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in Richard Owen's library - New Harmon
Apr. 5. 18

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KEY

TO THE

Geology of the Globe:

AN ESSAY,

DESIGNED TO SHOW THAT THE PRESENT GEOGRAPHICAL, HYDROGRAPHICAL, AND GEOLOGICAL STRUCTURES, OBSERVED ON THE EARTH'S CRUST, WERE THE RESULT OF FORCES ACTING ACCORDING TO FIXED, DEMONSTRABLE LAWS, ANALOGOUS TO THOSE GOVERNING THE DEVELOPMENT OF ORGANIC BODIES.

BY

RICHARD OWEN, M.D.,

PROFESSOR OF GEOLOGY AND CHEMISTRY IN THE UNIVERSITY OF NASHVILLE.

The sum of *wisdom* is to *know* the laws by which the universe is governed; the sum of *virtue* is to *obey* them.

ILLUSTRATED BY MAPS AND DIAGRAMS.

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Dedication.

HAD not academic and other duties forbidden, the writer would have at once submitted, in person, the results of his labors to the great patriarch of Physical Geography and Geology, Alexander Von Humboldt; and, with his sanction, if obtained, would have dedicated this Essay to him, as a guaranty to the Public that it was worthy of perusal; but in default of these facilities, the writer throws himself on the generosity of those "Searchers after Truth" who will not adhere to established suppositions merely because they are old and respected; nor reject newly-advanced opinions, without due examination, simply because they are new or startling; provided such opinions are brought forward with sincerity, and with deferential regard for the final decision of that enlightened and impartial body of readers.

To an enlightened PUBLIC, then, with all due hesitation regarding the propriety of obtruding on them assertions sometimes not fully proved, and with many apologies for the imperfect manner in which the original design has been carried out, this Essay is consigned for kind approval, if deemed worthy; or, if found wanting, for a rejection at least *not* unkind, it is hoped, inasmuch as so little is assumed by

The Author.

ERRATA.*

1. *Errors in Writing:*

At page 24, line 14th from top, for "encountering the earth's diurnal motion," read, "following the earth's diurnal motion;" and two lines farther on, for "produces vibratory motion from east to west," read, "produces vibratory motion in the *same* direction."

At page 26, line 17 from bottom, for "there be," read, "there is."

The use of the term "placental type," on page 87, is liable to be misunderstood, as applied to a country containing chiefly animals usually denominated implacental; unless with the qualification that materials, in the placental animals *deciduous*, are here supposed to be *retained* for the formation of a permanent extra-uterine source of fœtal nourishment and protection.

At page 122, omit the words, "and the conversion of gelatin into albumen by oxygenation:" in this connection read observations on page 163.

In *Mercator's Map* (No. 1) insert the word "stratified" before the words "protogine, serpentine, and eurite," among the Metamorphic rocks, otherwise they would appear to be Plutonic.

Ibid: In the parenthetical portion of the title given to this Map, interpose the word "chiefly" between the words, "the latter" and "by dotted lines."

2. *Errors in Typography:*

On page 11, for "Johnson," read "Johnston."

On page 25, for "phœnogamia," read "phænogamia."

On page 39, for "Furca, Pass," read "Furca-Pass."

In note to page 41, for "Johnson," read "Johnston."

On page 71, for "X^{V}," read "X^{IV}."

On page 92, for "clearage," read "cleavage."

On page 96, for "systematic," read "systemic."

On page 186, for "efferent," read "afferent."

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* It was found that there was room to place the *Errata* in the first sheet, containing title-page, etc., as that was not struck off until the remainder of the work was printed. The table of errors was, therefore, assigned to this position, as presenting to the eye the furnished corrigenda, bef[illegible] reader had been unfavorably impressed by seeing inadvertencies, which might be supposed u[illegible] and uncorrected on the part of the writer.

On page 164, for "pinacle," read "pinnacle."

On page 208, for "medula," read "medulla."

8. *Errors in Lithographing:*

Mercator's Map of the World. Consider this as "Map No. 1" of the text, the number having been omitted in lithographing.

Ibid: The Great Circles A^{I}, A^{II}, A^{III}, are not executed with mathematical accuracy, and enclose, consequently, somewhat more space than they should do, north of the points W, T, and V.

Ibid: For "palœozoic," read "palæozoic."

Ibid: For "quarternary," read "quaternary."

Ibid: For "AI, BI," etc., read "A^{I}, B^{I}," etc.

Map 2: For "quartenary," read "quaternary."

Ibid: For "palœozoic," read "palæozoic."

Diagram I.: The curved line indicatiug the end of the Tertiary Period is, by mistake, brought only as far south as Cape Sable, in Florida, instead of curving round by the Caribbean and Mediterranean Seas.

Diagram II.: For "Anglo-Teutonio," read "Anglo-Teutonic."

Diagram III.: For "fig. 8," on the left, denoting the germination of seed, read "fig. 6."

Diagram V.: A few impressions were struck off before it was observed that the largest Circle, embracing the whole animal kingdom, was omitted.

Ibid: In the Circle of Mammals, for "8000," read "2000."

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Preface.

No one can dislike more than does the writer of this short essay, mere fanciful hypotheses, which can lead to no useful practical result; therefore, if the brief suggestions contained in these pages were only flights of the imagination, instead of being an attempt, from a collection and comparison of known facts, to infer by deduction a larger class of general truths, which we may at least feel justified, from their apparent consistency and harmony, in assuming as such, for the purposes of directing our researches, until we can prove or disprove their validity—were this, be it repeated, only the case, none would be more ready than the author to withhold such hypothetical reasoning from publication.

But when collections of facts in one science seem so to classify themselves as to point to an apparent design in the all-wise Creator of the universe to model all upon the same great and perfect type, it becomes a question whether any slight misgivings, as to the first reception of such an announcement, should be sufficient to induce an ardent admirer of the works of nature, and a profound reverer of their Omniscient Architect, to shrink from exhibiting for discussion facts designed by their contemplation to increase our admiration of His works, when the chief reluctance experienced consists only in the knowledge that those supposed facts are liable to criticism, and sure to encounter it.

The avowal on the part of the writer of his own consciousness how imperfectly he has performed the task assigned him, and how

skeptical he himself felt when these apparent truths were forced upon him, may perhaps aid in disarming or modifying that criticism to which the writer by no means professes indifference.

Indeed, next to fulfilling the high duties incumbent upon him, nothing would be more gratifying than to secure the approbation and esteem of wise and good men.

When a writer places before the public a name unknown to science, it is perhaps desirable, if not imperative, that he should state briefly to that public his sources of information and his facilities for acquiring what he claims.

In accordance with this view, it may perhaps be deemed not irrelevant or egotistical to state briefly that the writer—whose father, Robert Owen, formerly of New Lanark, Scotland, purchased New Harmony, in Indiana, for the purpose of endeavoring to carry out his philanthropic social experiments, whose eldest brother, now resident minister from the United States in Naples, has written several works, and whose next brother is well known for his geological researches and publications—had the advantage not only of intercourse with these members of his family, but also with his talented and lamented brother-in-law, R. H. Fauntleroy, of the Coast Survey; and with Joseph Neef, father-in-law to the writer, formerly professor in the institution of Pestalozzi; a man, like that great educator, of original and practical views on educational points, of high classical attainments and general scientific information; also, to a considerable extent, with the celebrated naturalist, Thomas Say, who lived many years in New Harmony, and died there; also with C. A. Lesueur, whose expedition as naturalist with La Perouse, and whose researches and fine illustrations, particularly of the fishes found in our western waters, have rendered his name familiar to scientific men.

A residence of twenty-eight years in this country, (after the groundwork of a European education, chiefly in the institution of Emmanuel Fellenberg, at Hofwyl, Switzerland, including also a course of lectures from Dr. Ure, in the Andersonian Institution, Glasgow,) during which time the writer has been partly engaged in manufactures connected with agriculture, partly in a fifteen months' campaign in Mexico, as captain in the Sixteenth Infantry, one year assistant geologist in the corps of his brother, and for the last seven years Professor of Geology and Chemistry in the Western

Military Institute, now the collegiate department of the University of Nashville—a task undertaken in a great measure for the advantages accruing to his two sons, now in the college—all these have afforded him, if not the best facilities for study, while thus actively engaged, at least opportunities for very varied observation.

The natural tendency of his mind, aided by the early similar direction given by his father, have induced a constant wish to generalize; to construct synoptical, tabular views and illustrative diagrams of the analogies and homologies or affinities in every subject studied, and to examine their connection.

Latterly, the facility of attending valuable courses of lectures, under the able professors of the Nashville Medical College, has furnished data for the comparison of man's anatomical and physiological structure, not only with that of the lower animals, but also with that found in the other kingdoms of nature.

Much information has been derived from the works of Prof. Richard Owen, (formerly of the College of Surgeons, London, and now lecturer in the British Museum,) of Thomas R. Jones, and of Dr. Carpenter, in Comparative Anatomy; of Hitchcock, Murchison, Trimmer, Keyserling, De Koninck, Mantell, H. Miller, Buckland, Pictet, D'Orbigny, Lyell, Verneuil, Dana, St. John, and especially of Agassiz, in Geology and collateral branches, (besides the pleasure of some personal acquaintance with the five latter gentlemen;) also from referring to such works as those of Humboldt, Alex. Keith Johnson, Mrs. Somerville, Guyot, Colton and Fitch, etc., on Physical Geography; from consulting, in other departments of science and miscellaneous knowledge, Lardner, Davis's Manual of Magnetism, Congressional Documents furnished by the officers of the army and navy, (as Gilliss's United States Naval Astronomical Explorations, Stansbury's and Marcet's Expeditions, Examination for the Pacific Railroad Route, Census of the United States for 1850, as tabulated under directions of De Bow, etc., etc.,) Kane's Expedition, Stanley's Sinai, Lynch's Dead Sea, Layard's Babylon, Mitchell's Stellar Worlds, Jamieson's Europe, the Encyclopædia Britannica, Iconographic Encyclopædia, Annual of Scientific Discovery, the Scientific American, Brande's and Ure's Dictionaries; besides Silliman, Liebig, Wells, Fresenius, Faraday, Fownes, Youmans, and others, on Chemistry; Schleiden, Mrs. Marcet, Woods, and Coultas, on Botany; Reese, Ruschenberger,

and Woodward, on Natural History; our regular College Text-Books in Medical Science, (Paget, Horner, Woods, Mitchell or Pereira, Druitt, Ramsbotham, Taylor, Ashwell, etc.;) also, particularly, Draper's late work on Physiology.

It would be injustice, however, to these and other scientific gentlemen, as well as to the writer, were he not to state that, to his great regret, time did not permit him, without interference with other duties, to read some of these works even once through, much less to do them justice; and for want of facilities to obtain them, he was unable even to consult other works, which he feels assured would have eminently aided him; such as the valuable writings of Cuvier, some of Professor Owen's, those of Lindley, Gray, Boué, Egerton, Portlock, Phillips, De la Bèche, Ansted, Von Buch, Elie de Beaumont, Lieutenant Maury, General Sabine, Captain Wilkes, Dana, (on Australian Geology,) Dr. Livingstone on Africa, and the contributions of a host of others to the cause of science.

The author takes pleasure in stating, that for many facts regarding the later discoveries in Botany, on which subject the writer has been able to bestow too little attention, he is indebted to the kindness of Dr. Blackie, of Edinburgh, (Curator of the Botanical Society of Edinburgh, and brother to the well-known classical professor of that name,) during a recent visit to Nashville, while making a botanical tour of the United States.

For some discussion of the mathematical laws involved in this examination, he has to return thanks to Major Downie, formerly professor in the Western Military Institute; to Major Hamilton, Professor of Mathematics in the above college, which now constitutes the Literary Department of the University of Nashville; and to the Superintendent, Col. B. R. Johnson; also to Prof. J. H. Stewart, on the subject of Magnetic Oscillations.

It may be proper here to remark that the early hints on these subjects, cautiously thrown out by the writer, at first elicited considerable merriment at his expense, and were viewed by some only as coincidences, not indicative of any general law; and the writer was often prompted to abandon the investigation; but every lecture delivered and every work read seemed to bring forward some confirmatory evidence and to compel further examination. At the same time the writer felt forcibly, while attempting to work out many details, particularly involving a knowledge of the higher

branches of Mathematics, or of the minutiæ in Anatomy, Physiology, and Chemistry, as well as various other branches, his own deficiency; and he has, therefore, in many instances only alluded slightly to analogies, etc., which, if the system is based on truth, will suffice to point the way to each in his own branch of science; while, if the writer is really in error, he has already said too much.

The author is pleased to find that, without straining any point for that purpose, the geological propositions advanced not only present no conflict in their general development, but even furnish additional evidence in favor of scriptural records. And, if he is not mistaken, there is also no conflict in these attempted explanations of the earth's development with La Place's nebular hypothesis, or with Lyell's just enunciation in his great work, "The Principles:" "That all is due to forces similar to those now in operation;" nor is there any material variance with the advanced opinions contained in any of the standard works to which the writer has had access, emanating from the pen of distinguished men.

To the Chancellor and many members of both Faculties of this University he likewise desires to acknowledge his indebtedness for lending him works of reference, and to the Medical Faculty for valuable advice in their department.

At the same time, while thus publicly acknowledging the aid rendered, the writer does not expect or desire any one to assume the responsibility of such errors as may be detected, and for which the want of knowledge, time, and necessary care on the part of the writer, must bear the blame, or perhaps, to indulgent critics, may offer some apology.

The reader may here very properly inquire, Why then obtrude upon the public unfinished demonstrations and crudities? The reply to this may be facilitated by briefly stating the circumstances which led to the present systematic investigations, and by adverting to the duties incumbent upon the writer in his present position.

Some months since, while bringing to a close his lectures on Geology, delivered at the request of the Chancellor, Dr. Lindsley, to the Medical Students and to the Seniors in the Literary Department of the University of Nashville, the writer became especially desirous to place before them some great principles of generaliza-

tion, by which they could more readily remember the previously stated details.

While occupied in endeavoring to work out this general system, he placed on the floor of a vacant room all the geological maps which he possessed, in their correct relative position. These are chiefly from the surveys made in the United States. Alongside of them he had Lyell's Map of the Geology of the United States, and Professor Hitchcock's map appended to his Geology of the Globe. While contemplating the latter, (compiled chiefly, Hitchcock remarks, from Johnston's Physical Atlas,) there suddenly flashed upon him the idea that the formations in the Western Continent corresponded in many respects to those in the Eastern; and he fitted, adjusted, and moved them apart and together, until it appeared to him that they must have been detached *at some period* from each other. The longer he examined the subject, the more this first conviction was confirmed into a certainty. The next point was to find the law according to which they had separated; and, after much deep and perplexing investigation, he thought he perceived the great truth.

The numerous duties which his position as Professor and as Treasurer in the Literary Department of the University imposed upon him, prevented his giving to the minute details that rigid attention which it would otherwise have been his pleasure and his duty to devote to them. The question then arose, as he has just stated, whether he would be justified in offering to the public, in their present crude and undeveloped state, these supposed truths, or whether he should wait an indefinite period for full time to examine and enunciate the detailed proofs. Well aware that, in this age of railroad speed, long delay is unpardonable; and knowing that even if he obtained the leisure, (a very problematical contingency, although the Faculty kindly lightened some of his labors,) there were scientific men around him, each better informed than himself in his own department; and, further, that suggestions, like machinery, usually are made by one to be improved upon by others, he decided, with deference and hesitation, to place his very imperfect system of generalization at the bar of the public scientific tribunal.

In a few instances, doubtless, the above hurry and necessity for briefness may have caused the writer occasionally to span some

chasms of thought, and to leave untopographed the intermediate ideal sketch; but it is hoped this has not occurred so frequently as to render the general idea unintelligible. The truth is all that he desires to elicit: therefore, provided he has made himself understood, if (when each in his own branch of study has examined the "Key," and found, after careful adjustment, that it does not open the way to any new facts) the final judgment of the majority should be against the writer, he will doubtless feel mortified, but he will thankfully receive the correction which prevents his propagating error, and will endeavor to console himself under circumstances that have overtaken many a worthy individual, by balancing the profit and loss (involving reputation and pecuniary means) with an entry on his life's ledger debiting Experience Account.

If, on the other hand, the scientific public should decide that the writer has pointed the way to important truths, he trusts never to feel for a moment aught but humility and gratitude, deep and heartfelt, that he should have been made the humble instrument in the hands of Omnipotent Wisdom to contribute some facts to the great cause of Human Knowledge and Improvement.

To show the public that, however imperfect the demonstration, and however far himself from possessing the qualifications necessary to do justice to the subject about to be discussed, the writer is at least aware what those qualifications *should be*, he here subjoins a short sketch of his idea regarding them.

An investigator should bring to the subject which he desires to establish or maintain, a mind untrammelled by any peculiar doctrines, and a sincere and single-hearted desire for truth. He should be a man who loves science for the sake of the knowledge it imparts, bringing him as it does more nearly into that communion with his Maker which may perhaps be followed in a future existence, when we no longer "see through a glass darkly," by a full explanation of God's divine and immutable laws.* A man whose energies urge him to constant action, but whose impatience brooks all *necessary* delay: A man who maintains his fortitude alike unshaken amidst storms and calms, adversity and prosperity; capable, amid the stirring and afflicting incidents of life, of giving the best

* This has been beautifully suggested by the highly talented Dr. Dick.

sympathy and aid of a benevolent heart, but yet having that warm heart entirely under the control of a cool and calculating judgment, knowing such occurrences to be among the necessary and unavoidable evils of life: A man who, in classifying, *does not neglect* the minute specific characters dependent on external resemblance of locomotive organs, etc.; who *regards more*, however, the differences taught in odontography, leading to difference in habits and nutritive system; but who *values most* the distinctions pointed out by variations in those important vital organs constituting the vascular and nervous systems: A man who delights to roam in the valley, and critically examine the records of bygone ages, but is still more enraptured by the boundless view from a Rigi-like summit of one of Nature's lofty peaks; who respects details for their congregated facts, but values them more when arranged into a system: One who, when his feet falter on the slippery precipice of life, or his eyes are appalled in its shadowy and bewildering vale, fixes his upward gaze on the Divine Essence of light and life, as the beacon and goal of his existence. In short, the investigator of scientific truths should be one who has no prejudices to defend, no favorite theory to support: a man as ready to yield justice to the meanest menial as to the proudest peer: one who can feel with the acuteness of the poet, and judge with the coolness of the philosopher.

Far, very far be it from the humble individual who has penned these pages to claim that he possesses one tithe of these requisites: on the contrary, he is struck with his own temerity in thus venturing (while aware that he cannot say how one atom of dust came into existence, and knowing the more than gossamer tenuity of the bond by which the Almighty fiat holds this our mortal frame suspended over the gulf of eternity) to fathom the formation of the universe, and to trace out some of the laws of Divine Wisdom. But with this full conviction of apparent rashness, and with a keen sensibility of his own deficiency, he remembers also the prayerful entreaties he has, through life, ardently offered to the Fountain of all wisdom, that he might be permitted to obtain some insight into the immutable laws by which the world is governed; and he humbly, yet fully and conscientiously believes that, in answer to these earnest prayers, the Almighty Ruler of the Universe has vouchsafed to so humble an individual as the writer a correct insight into some small portion of those immaculate and wondrous works.

It is but an act of justice towards himself, for the writer to state that when, in May, 1856, the first ideas, now embodied in this essay, forced themselves upon him, he had never seen or heard any thing from others which could lead him to suppose that such views had ever been entertained, or were likely to prove acceptable. Since that period, when he sketched briefly the plan of development to his students and to a few friends, his attention has been called to occasional sentences from various writers, evidently having the same general bearing. Other minds doubtless have had foreshadowings of these truths; and the writer intends to enter into no controversy regarding claims. His chief object, as before stated, is to arrive at Imperishable Truth. He contends only for sincerity in expression, and for boundless gratitude in feeling, that he is permitted to add one link to the great chain of human knowledge, and perhaps to incite the human mind to the contemplation and investigation of God's divine laws, a knowledge of which is the highest wisdom; and, lastly, to urge, by every argument which reason or interest could dictate, the living constantly in accordance with those immutable laws, in the practice of which consists the sum of virtue, the essence of temporal and eternal happiness.

Here the writer wishes to add to his previous acknowledgments of indebtedness, his sincere thanks to the Publishers, who have promoted his efforts by their widely known imprints, and to Mr. A. A. Stitt, of the Southern Methodist Publishing House, who has kindly brought his acute energies to bear on the important revision of perplexing details.

He also desires to call attention to the fact that the German gentlemen who undertook the lithographic work, although occasionally perhaps led, by their want of intimate acquaintance with the English language, into minor errors of detail, have evinced a thorough knowledge of their art, if we make due allowance for the want of greater artistic facilities which they possessed in their own country; and the writer can testify to their having performed their work not merely as correct mechanical copyists, but as men comprehending the principles involved.

Perhaps it may here be permitted, in concluding these prefatory remarks, to add further, that the evils of a highly excitable nervous temperament, and of maternally hereditary dyspepsia, have been kindly soothed and alleviated by the agreeable relationships which

a beneficent Providence has permitted to exist for nearly twenty years; and the writer, having passed the meridian of life by one year, feels thankful for the blessings which surround him, and prays for the welfare of those kind friends, and for a continuance of such health of body and mind as may still enable him to study the great laws governing the universe; or, if that may not be, at least for strength to meet such reverses as are yet to come. Should these reverses arrive, the writer will at least have used his best judgment to avoid them, by abstinence from all highly stimulating diet, (even animal food,) and from all stimulating beverages, including coffee; by adherence to early hours, and by an *attempt* at the attainment of that tranquillity which has secured to his father, at eighty-six years of age, an active, healthful, and happy career of usefulness.

If the comparison of man's life with that of the ephemeral insect be admissible, the writer would say, in conclusion, that when the Omniscient Author of his existence calls upon him to exchange, larva-like, his short earthly career for the cold and silent chrysalis-sleep of death, preparatory to a glorious and perfect existence hereafter, he asks no higher posthumous honor than to have the following short lines engraven after his name, on a plain white slab, as his

EPITAPH:

"His first desire was to be virtuous;
His second, to be wise."

UNIVERSITY OF NASHVILLE, 31st December, 1856.

Introduction.

In order that this attempted contribution to our present knowledge should be rendered as readily intelligible as practicable, even to those who have not devoted themselves exclusively to the study of science, I* venture to lay down a few general principles, which it is supposed will be admitted by the majority of scientific men.

As it would occupy too much time and space here to discuss them, they are assumed as self-evident theorems or

AXIOMS.

I. The sun is probably the remote source of all stimulus, and stimulus the cause of *motion*. Also, wherever there is motion, there is accumulation and deposition of new materials, (*ubi irritatio, ibi fluxus*,) and dissipation or consumption of the old.

II. The phenomena of heat, light, and electricity, (the latter in all its forms,) may result from modifications of motion, (vibratory or undulatory, disturbed equilibrium, etc.,) and many facts point to a similarity or connection between volcanic, electrical, and nervous agency.

III. Opposed to motion, and hence always tending to produce

* In those few cases where it becomes necessary, in the body of the work, to employ the personal pronoun, it is proposed, for the sake of brevity and clearness, to use it in the *first* person singular.

an equilibrium, but perhaps only another phase of motion, is *attraction*. This, when rendered evident between masses of matter, is called gravitation; between smaller, cohesion; between different kinds of inorganic bodies, chemical affinity; between organic bodies, preference or affection.

IV. When attraction overcomes motion, the molecules of the body are able to arrange themselves according to their poles, and to form solids; when neither force predominates, we have liquids; when motion overcomes attraction, and the molecules are no longer arranged according to their poles, we have vapors, to which, however, we give the name of gases, if the natural heat of our atmosphere is sufficient to keep up this separation, and thus render them, under ordinary circumstances, permanently elastic fluids.

V. In the structures hitherto most investigated, the Omnipotent Creator of the universe has evidently worked on one type or general plan. It is therefore probable that the same general plan pervades the less intimately known structures of His all-perfect system.

VI. The earth, in some of its former geological epochs, occupied a smaller volume than before the whole of the present superficies emerged from the ocean, and than it did before some of the later successive layers were deposited on the earlier formations.

VII. The tendency of inorganic matter is to assume more angular forms than those acquired by organic bodies; the latter inclining to rotundity or curvature.

VIII. The most highly organized plants are in *some* respects more complete than some of the lowest animals; just as the highest classes in a low zoölogical department may exhibit some organs which are more perfect than those found in the lowest classes of the next higher department of animals.

IX. Plants in their higher organization typify the bisexual development of the higher animals.

X. In at least all the more highly developed plants, as well as among the higher animals, there is generally a placenta or medium of communication between the parent and offspring. This in plants is developed usually at each of the two edges of the carpellary leaf; in animals, by the internetting of fœtal vascular tufts with maternal blood-sinuses.

XI. Certain embryonic envelopes, in the animal ovum, give rise to particular organs in the future individual; thus:

1. The outer or *serous* layer gives rise to the organs of animal life, (nervous, osseous, and muscular systems.)

2. The inner or *mucous* layer, to the organs of nutrition and reproduction, (organs of vegetative life: stomach, intestines, etc.)

3. An intermediate layer, the vascular, to the organs of respiration and circulation.

(See Agassiz and Gould's Principles of Zoölogy, page 112.)

XII. Whenever there is a deficiency, from want of nervous energy, from defective nourishment, or from any other cause, in an embryonic envelope or vitelline layer, there is liability to a deficiency, atrophy, or hyponormal state of the organs formed from that layer; and, *vice versâ*, an excess of material or of energy produces the hypernormal state: this is true also at a later period, applied to the growth of the individual.

XIII. If a tegumentary layer be removed from a fully developed animal body, with a portion of the cellular texture, containing the hair-bulbs, etc., no hairs or products of dermal growth will be afterwards produced on the cicatrix.

XIV. In animals, supposing the requisite amount of nutrition furnished, growth (of the fœtus, etc.) is due to heat and *nervous* agency. In plants, supposing earth, air, and water to furnish the necessary nutrition, the growth of the germ still demands or is greatly promoted by *electrical* agency; while in the mineral world, after the materials for accretion have been furnished, chiefly by segregation from water, the expansion, upheaval, disruption, and subsequent re-formation or blending by fusion, crystallization, etc., are due to *volcanic* agency.

XV. Internal force, acting from a less solid central mass towards a more solid crust, would, if it had activity enough, attenuate the plastic portion of that external crust, and elevate the more resisting parts, producing cracks and fissures where the plasticity diminished.

XVI. If heat be applied beneath the centre of a mass, the upper part of which is semi-fluid and the lower liquid, as the lower stratum begins to boil, it will slide the fragments of the upper in different directions from a central point.

XVII. Substances requiring the greatest amount of heat to liquefy them would consolidate the most readily on a diminution of that temperature.

XVIII. Statements now assumed as facts (for instance, that the earth moves round the sun) cannot be proved to all our senses; but must be admitted as facts, in opposition to the apparent evidences of some of our senses, because offering clear explanations, with the utmost mathematical precision, of numerous phenomena and facts otherwise unaccounted for.

XIX. In obtaining general results, we must expect to encounter some apparent, perhaps real, exceptions; and must be willing to disregard occasionally minute conflicting details, provided the masses are in conformity to some fixed rule.

XX. Nothing happens by chance; but every thing results, on the contrary, from certain immutable laws.

Upon close examination, it seems probable that some of these propositions laid down as axioms will not be admitted without some discussion; therefore they will be reverted to hereafter; but supposing the majority of the above principles granted as true, the next step is to announce, according to some order of succession, the problems which have to be demonstrated, chiefly bearing upon the development of the earth from its nucleiform position, and upon the formation of the organisms formerly, or now, existent upon the earth.

In laying down these problems to be solved, it will be convenient to follow somewhat the succession indicated in the Table of Contents; namely, to take up first those facts bearing on the visible geographical or geological appearances on our globe, and hence, as being comparatively in repose, termed *Statical Geology*.

The second problems and demonstrative facts will bear on the forces which have been at work to produce these present or past appearances, and are hence designated *Dynamical Geology*.

The third attempt will be to collect a sufficient number of facts to establish the generalization that a strong similarity exists between the plan of creation followed in forming the inorganic materials of the globe and the organic: hence termed *Anatomical Geology*.

The fourth and fifth series of facts will bear upon the evidences that soil and climate affected the organisms now found fossil, and continue still not only to modify the plants which grow within their influence, but even the animals, man himself included. These latter

proofs, however, will be given separately from those alluding to the lower animals.

The next problems bear on the evidence that certain diseases are prevalent in some regions, while a different class greatly preponderates in another country of dissimilar geological formation.

And the last problems will embrace such as, if the others be proved, would result rather as corollaries or practical inferences for improvement.

A synoptical view of the detailed problems may, for greater facility of examination, be thus condensed:

PROBLEMS.

I. The present form of the land exhibited above the water will be found, although apparently irregular in shape, to follow certain fixed rules in the directions of its coasts, mountain ranges, rivers, dislocations, caves, etc., as well as in the distances across continents, from one continent to another, across islands, and from islands to continents, etc., etc.

II. The different successive geological periods will be found more recent and less dense in structure as they leave the north pole and approach the equator. Although certain layers probably invest the globe, in a succession never inverted, yet, where upheaved, the edges or vertical sections of these formations appear to have been brought to the surface along concentric lines, which are parts of great circles intersecting each other in such a manner as to form equilateral spherical triangles on the earth's surface; each angle or intersection being equidistant from our present north pole.*

The most prominent equidistant lines may be readily traced on both maps, being marked A^{I}, A^{II}, A^{III}; B^{I}, B^{II}, B^{III}; etc., etc.; indicating the most distinct geological differences, while numerous intermediate similar triangles on the earth's surface mark less important periods.

III. The distribution of coal, of the metals, and of various other

* These great circles are the boundaries, doubtless, of intersecting planes, which appear to indicate that the internal nucleus from which we have these surface indications is or was a tetrahedron, a primary crystal, which may be obtained by truncating the edges of the cube, or, in other words, depriving it of four depressed pyramids, as any one can readily test by cutting a potato or similar substance into these forms. The cube or spherical tetrahedron probably gave rise to our now oblate-spheroidal earth. [See Diagram IV., fig. 12^{I}.]

mineral products, as observed on the earth's surface, corresponds with the direction of the lines marking these spherical triangles.

IV. The manner in which the development of the solid materials took place appears to have been very similar to the formation and expansion of vegetation,* somewhat as figured in Diagram III., fig. 6; and also to have resembled the deposition and expansion of new material in the covering of the mollusk or other animal as exhibited in Diagram III., fig. 7^{I}, 7^{II}; and also the same as in embryonic animal development, or utero-gestation.

V. The forces which separated the above described planes are supposed to have taken origin from the internal fluid materials being thrown into periodical waves by the attraction of the sun and moon, thus causing a constant disturbance of electrical equilibrium near the earth's surface; which, encountering the earth's diurnal motion from west to east, produced and still produces electrical vibratory motion from east to west, and causes a freely suspended magnet to settle at right angles to the direction of these electrical currents.

VI. The currents thus generated appear to be produced, in succession, periodically along all the intermediate planes, causing the variation in the whole magnetic system. The latter is at present moving, in the northern hemisphere, from west to east; and, in the southern, from east to west. (Mrs. Somerville's Physical Geography, p. 314.)

These changes are evidently connected with solar influence, so that diurnal and annual vibrations are computed with precision; and perhaps the longer periods of secular oscillations may be determined and found to occupy five or six centuries in moving from the greatest eastern extreme to the western limit, and again back to the place of beginning.

VII. A close examination and comparison of the layers constituting the earth's crust, show them, as before stated, to consist chiefly of the older Hypogene Rocks in the Arctic, and of newer Hypogene or Igneous in the Antarctic Regions; while Hypogene of the Secondary Period accompanies the Palœozoic and Mesozoic

* Any one, in moderately warm weather, can examine this minutely for himself, by allowing soft water, from an adjoining tumbler, to trickle, by capillary attraction, from a cotton wick, curved siphon-shape, on to a glass slab or common pane, upon which have been placed some seeds of various kinds, such as the white field bean, maize, etc., etc.

Rocks in the Northern Temperate Regions, and the Tertiary Hypogene or Igneous accompanies the Tertiary and later Aqueous deposits in the Tropical Regions. That these rocks correspond in many particulars to the organic developments, is the problem proposed in this section; being an endeavor to show that the Hypogene Rocks are the analogues of the *serous* or outer layer; the Secondary resemble the *vascular* or middle layer; and the Tertiary, the *mucous* or inner layer: The type of creation being a nucleus, a formative fluid and a cell-wall, the whole modified and developed by vitality, (volcanic, electrical, or nervous agency, stimulus, or motion, generated by the sun.)

VIII. Among the fossil flora, as well as in recent vegetation, we have proof that the growth of different periods acquires some of its peculiarities from the greater amount of a given material predominating through that period. Thus, in the earlier geological formations, the vegetation, fossil as well as living, consisted and consists chiefly of plants exhibiting a simple cell-structure, the cellular cryptogamia, while phœnogamia are rare. But at a later geological period, when these cells have been aggregated into tissues and coiled into spiral tubes, we have the vascular cryptogamia; while, as the cells of nutrition and of reproduction become specialized, (as when the geological aqueous deposits furnish more abundant materials for nutrition and reproduction,) the phœnogamia of one or two seed-lobes shoot, under more genial skies, into caulescent shrubs and into trees of multicentennial trunk-growth.

IX. The same holds good regarding the animal world; for while microscopic animalcules, myriads of Radiates, (corals among fossils, acalephs now,) also of pteropodous and acephalous mollusks, and of some of the lowest cartilaginous fishes, are comparatively abundant in early geological periods and in high latitudes, (not only as fossils, but as living organisms,) the highest Radiates, (Echini and Holothuridæ,) the highest Mollusks, (cephalopods,) the highest Articulates, (insects,) and especially the birds and mammalia, are proportionately much more numerous in the Tertiary Period.

The Mammalia of the Post-Pliocene Period have usually an excessive development of extremities and of dermal organs, formed from the latest serous layer.

X. Man himself is not exempt from the general law. When we find races established for many centuries in a high northern lati-

tude, their extremities are short, their organs of special sense are highly developed, while their animal passions are moderate.

In countries of the Secondary Period, we have the best admixture or balance of the nervous, vascular, and nutritive systems; consequently, the best-nourished and most energetic races, physically and mentally.

In the Torrid Zone, however, the heat develops the pigment-cells, which give to the Ethiopian variety its color, as it also does to the vegetable world in the same latitude, and stimulates the animal passion to excessive action. In these the forehead is low, hair crisp, and whole tendency downwards.

XI. As the races of man spread from their original cradle in the earth, (somewhere in the region of Palestine,) there appears to have been a successive national development, maturity, and decay, periodical in character, chiefly progressive in a north-westwardly direction, and to some extent alternate along its ascending node or axis, (as intimated in Diagram II.,) dependent perhaps on the greater amount of electrical and consequent nervous energy to be found, at first in one part of the globe and then in another, connected possibly with the secular vibrations indicated by the needle: just as progressively ascending energy has a tendency to produce in the plant verticillate development of reproductive buds, etc.

XII. If in any soil there be a great preponderance of some soluble inorganic material, which is taken into the nourishment of cereals or other plants used by man, (producing, perhaps, an abnormal state of the plant, as in the fungus-perverted rye, ergot,) diseases of particular characters may be engendered in those using such productions as articles of food; and, *vice versâ*, if a man or race of men happen to be born and nourished where some material, essential to the animal system, is deficient in the soil and in the consequent vegetation, then the man or race of men will probably be liable to diseases resultant from such deficiency.

In northern temperate latitudes, there is greater energy of, and greater consequent liability to disease in, the cephalic and thoracic organs, including the nervous system; whereas in southern climes, there is more liability to diseases of the mucous layer, (abdominal, reproductive, etc.,) and of dermal excess.

XIII. In tracing the appropriate remedies, it is sometimes in other formations that we must seek the therapeutic agents to di-

minish excessive or promote defective action; but perhaps more frequently nature has placed within reach of each tenant of his own soil the appropriate remedy, which, by increasing the action of the diseased organ, (or its absorbent aids,) causes it to excrete the excessive deposit of material not required to repair the periodical waste. Sometimes this is promoted by the vicarious action of another organ.

XIV. Should the problems stated above be substantiated by proof, it follows, as a necessary inference, that we have, by means to be pointed out in detail hereafter, on the one hand, so to diminish this excess of energy or material, or, on the other hand, so to increase them, as to surround the individual by the circumstances best calculated to favor normal and well-balanced physical, mental, and moral conditions.

DEFINITIONS OF TERMS

AND

EXPLANATIONS OF ABBREVIATIONS USED.

As misunderstandings frequently occur from our not attaching the same meaning to certain expressions, it may be well to define what is meant when using the following words or phrases.

1. *Earth's nucleus:* The original igneous materials, (probably thrown off from the sun,) after being sufficiently cooled on the exterior to assume a regular form. That form or nucleus is assumed to be a spherical tetrahedron, one apex of which coincides with our present north pole.* Possibly, if the same developments are repeated at the south pole, the nucleus may be a double pyramid, (or hexahedron.) The materials derived from aqueous solution or mechanical mixture (after the nucleus was sufficiently cooled to have an atmosphere, and consequently to have rain washing detritus from the higher parts of this igneous nucleus) were deposited in secondary planes on other portions of the nucleus or on the cell-wall, giving rise to the Secondary form of crystal.

2. *Secondary Form of the Earth:* A figure assuming nearly its present oblate-spheroidal appearance, but having a different distribution of land and water, before the later materials were de-

* This, besides at once pointing us to a resemblance between the earth and the regular mathematical figures assumed by minerals, will be found, on examination to be the analogue in the vegetable world of the central ovule-sustaining placenta.

posited in the southern regions, and afterwards brought to the surface by igneous upheaval.

3. A *Lune* is a portion of the surface of a sphere included between two semicircles intersecting in a common diameter of the sphere. (Davies' Legendre, Book ix.)

4. A *spherical wedge* or *Ungula* is that portion of a solid sphere included between two planes passing through the centre, and the lune which forms its base. (Ibid.)

5. *Liquefaction:* Conversion of a solid into a liquid by means of heat.

6. *Solution:* Conversion of a solid into a liquid by union with water or other chemical solvent.

7. *Straight line.* Of course, mathematically speaking, we cannot have straight lines uniting two points on the earth's *surface;* but, to prevent misunderstanding, it may be well to mention that sometimes, for convenience, or even inadvertently, this term may be used when the intention is to designate the shortest line between two or more points following the curvature of the earth's surface.

8. The Magnetic Poles and Foci of Magnetic Intensity (the latter determined by the number of oscillations in a given time) are chiefly taken from Mrs. Somerville's Physical Geography, and are placed and abbreviated as follows:

American Magnetic North Pole, in about longitude 97° west of Greenwich, latitude 70° north, (abbreviated Am. M. N. P., on Map No. I.,) as determined by Captain Sir James Clark Ross. (Ph. Geo., p. 312.)

In Lardner's Handbook of Natural Philosophy, Blanchard & Lea's edition, 1853, at page 209, it is stated that Sir James Ross, in his voyages made between 1829 and 1833, found the dipping-needle to stand vertical at 70° 5′ 17″ N. lat., and 114° 55′ 18″ W. long. This is consequently indicated on the Map No. I. by a star and an arrow pointing to it, from the other assumed magnetic north pole. Hansteen placed it in 80° N. lat., 96° W. long.

Siberian Magnetic North Pole (abbreviated S. M. N. P. on Map I.) is not yet considered as being *positively* determined, so far as I can ascertain. Erman places it in Northern Siberia; Hansteen placed it in 81° N. lat. and 116° E. long. It is placed theoretically in about 75° N. lat. and 98° E. long. from Greenwich.

The Magnetic South Pole is placed by Sir John Ross in the

interior of Victoria Land, 75° 5′ S. lat. and 154° 8′ E. long. It is indicated on Map No. I. by the abbreviation Mag. South Pole.

Focus of Maximum Magnetic Intensity, No. 1, designated on the Map as Intensity No. 1, because the most powerful, was determined by Sir James Ross, and is in 60° S. lat., 131° 20′ E. long.

Focus of Maximum Magnetic Intensity, No. 2., (on the Map, Intensity No. 2,) is south-west from Hudson's Bay, latitude and longitude not given.

Focus of Maximum Magnetic Intensity, No. 3, (on the Map, Intensity, No. 3,) is in Northern Siberia, in 120° E. long., lat. not given. It is placed theoretically in about long. 115° E., lat. 70° N.

Focus of Maximum Magnetic Intensity, No. 4, (on the Map, Intensity No. 4,) is placed by M. Erman in the South Atlantic, 20° S. lat. and 324° E. long.

9. *Behring's Strait* (assumed to be a decussating point or intersection of great circles, bounding planes along which electrical and magnetic forces exhibit dynamical energy, and perhaps also the former north pole of the earth) is so nearly on the Arctic Circle, opposite the Alpine Median Line, (see Definition 10,) that it is theoretically so considered. If it ever was the north pole, the *then* equator must have coincided with our ecliptic, when it decussates our present equator in the region of Quito, on the Western Hemisphere, and of Natal, in Sumatra, on the Eastern Hemisphere.

10. *Alpine Median Line* (abbreviated Alp. M. L., and marked on the Map of the World X^{I}, X^{II}, X^{III}, X^{IV}, is a great circle passing through Behring's Strait, through the region of the Malström near the island of St. Thomas, (where the Terrestrial and Magnetic Equators coincide.)

11. *American or Ando-Siberian Median Line* (abbreviated Am. M. L., and marked on the map Y^{I}, Y^{II}, Y^{III}, Y^{IV}) indicates a curved line, bounding a plane passing through the north and south poles at *right* angles to the plane bounded by the Alpine Median Line. This line, at its intersections on the equator, is consequently 90° from the intersections of the Alpine Median Line on the equator.

12. The *Present North Pole* of the Earth and the *Present South Pole* may sometimes be abbreviated by using the initial letters P. N. P. and P. S. P.

13. *Analogy* indicates the similarity of purposes or functions performed by organs of different structure.

Homology or Affinity is the relation between organs or parts constructed on the same plan. (Agassiz and Gould's Principles of Zoölogy, p. 6.*)

* According to the definition here given, I had imagined that I would be justified in using the term "*Homologues*" for two organs which I considered as having the same type for their basis of construction; but observing more recently that Dr. Carpenter does not admit a homology, only an analogy, between the gill of the fish and the branchial tufts of the Sabella, I conclude the term "*analogy*" would be more generally considered applicable to the similarity or resemblance intended to be pointed out, even when there is a general type for the basis of structure.

KEY

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GEOLOGY OF THE GLOBE.

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Geology of the Globe.

CHAPTER I.

Physical, Statical, or Geographical Geology: exhibiting a systematic generalization of the present external appearance of the globe, immediately resultant from physical and geological changes.

In pursuing this investigation, it will be found most convenient to use a good-sized, accurate globe, as Cary's, or a small hand-globe, detached from an orrery, with movable horizon and brazen meridian, tracing the lines with India ink, in a camel's hair brush, and making the measurement with some unelastic material. Or, in default of such facilities, even in addition to them, we should employ a good atlas, such as that recently published by Messrs. J. H. Colton & Co., of New York.

For the sake of clearness and brevity, we shall distribute the collected facts designed to be used as justifying general inferences, into one or other of the first three problems laid down in the introductory synopsis, thus:

I. *Facts designed to prove that the present form of the land, exhibited above the water, will be found, although apparently irr*

gular in shape, to follow certain fixed rules, in the directions of its coasts, mountain ranges, rivers, dislocations, caves, etc., as well as in the distances across continents, from one continent to another, across islands, and from islands to continents, etc., etc.

It may be well here to remark, once for all, that in furnishing details, only a few of the most prominent and characteristic will be given, deducing thence the generalization; and the reader will be left to apply as many more *facts* as he can conveniently recall to memory, for the purpose of verifying or of refuting the deduction.

The first step, in accordance with the above plan, is to collect the facts regarding the *Direction of the Coasts*, in their great outlines; also of the mountain ranges, rivers, etc.

Here we at once perceive, if we elevate the north pole of the globe 23½° above the horizon, that, when we revolve the globe, we bring many of the great continental coasts, as well as shorter gulf and island coasts, successively to the horizon, proving their parallelism: for instance, the *west* of North America, (California,) part of the western coast of Southern Africa, (coast of Guinea,) west coast of Arabia, India, Birmah, Malaya, Sumatra, Corea, Australia, and Borneo.

Now depress the north pole 23½° below the horizon, and you bring the *eastern* coast of North America, (Atlantic seaboard of the United States,) the *east* coast of Southern Africa, and the general trend of the eastern Asiatic coast, (between Behring's Straits and the Gulf of Siam,) successively parallel to the horizon.

A third set of coasts will be found parallel to the horizon, when we elevate the *equator* 23½°; in which case the west coast of Central America, the northern coast of South America, the general direction of the Mediterranean coasts running from east to west, will be included in the number, and will be observed to be chiefly intertropical; while those previously pointed out are, for the most part, between the equator and the arctic circle or the equator and antarctic circle.

North of the arctic circle, the coasts, mountains, and rivers chiefly trend either to Behring's Straits, to the Present Terrestrial North Pole, or to one of the Magnetic North Poles.

Any land considerably south of the antarctic circle will, in all probability, be found to have arranged itself according to the attractive force of the Terrestrial or of the Magnetic South Pole;

some coasts necessarily, however, running (as laid down from Captain Wilkes' Explorations) in an easterly and westwardly direction.

The general direction of the mountain ranges being intimately connected with the forces which are supposed to have given to the earth its present form, in obedience to certain laws of its Omnipotent Creator, would bring a portion of the discussion regarding them more properly into the next chapter.

Suffice it, for the present, to point the reader to the fact, that while some ranges follow the same direction as the coasts, (for instance, the Rocky Mountain and Andean Ranges parallel to America's western coasts, the Alleghanies to North America's east coast; or the Ghauts corresponding with the coast of Hindostan, etc., etc.,) the great majority of mountains in Asia, east of the dividing Urals, will be found converging in their *strike* or line of direction towards the highest Himalaya, Hindoo Koosh, and Kuen Lun peaks, while those west of the Ural Mountains, including those of Arabia and Europe, are seen to trend to the highest mountains in Europe, the Alps, as a central focus.

DIRECTION OF RIVERS.

Beginning in North America, we find from the centre of the continent, say near the lakes, in or about lat. 45° or 50°, that we must diverge north-east towards Labrador on the one side, and north-west towards the region of Mounts Brown and Hooker, on the other, in order to find the heights of land, from which flow north the waters draining into Hudson's Bay and the Arctic Ocean, or southerly into the Atlantic or into the Pacific. In the same direction a continuous chain of lakes and streams renders it possible to paddle a canoe in high water from the Arctic Ocean, supposing the waterfalls passable, to the mouth of the St. Lawrence; and a few feet of depression in North America would create an Arctic continent. The main central drain, finally absorbing all the smaller streams and sweeping through the great valley of the Mississippi, brings the detritus of a thousand hills to repose in the Gulf of Mexico.

In South America the dividing ridges form a similar angle in or about 20° south of the equator, diverging north-west towards Chimborazo; and north-east towards the mountains of Brazil, (as the Cordillera de Barborema, etc.)

In Africa (for reasons to be hereafter discussed) the interfluvial heights are some twenty degrees farther north in the region of the equator.

The great summit-level for the waters of Western Europe is undoubtedly the Alps. Standing on the Furca, unaided human vision can, by a single turn of the head, see the region whence the head-waters of the Rhine commence a rippling course, destined finally to collect and empty the various tributaries into the North Sea; and the same glance can also distinguish the source of the Rhone, which guides many south-flowing streams to its Mediterranean Delta. From the Alps a line running north-east, nearly through Moscow, towards the Ural Mountains, will subdivide the rivers of Eastern Europe into northern and southern streams.

In Asia, from a point south of Lake Baikal, in or about latitude 45° N., not far from the ancient capital of Jenghis Khan, we again, by following the same diverging north-west and north-east ridges, separate the rivers flowing north from those flowing south.

DISLOCATIONS, WHIRLPOOLS, CAVES, ETC.

Along the Alpine Great Circle laid down on Map I., as X^{I}, X^{II}, X^{III}, X^{IV}, and described in definition No. 10, beginning at the north pole and travelling south, we encounter, in or about the meridian 8° to 10° E. of Greenwich, the west coast of Spitzbergen; then we pass near the Malström, striking the Dofrafield or Scandinavian Mountains, where they assume a north and south direction, forming table lands 2000 feet high, and we arrive in the neighborhood of Frederick's Stadt, not far from which "the family seat of Borge suddenly sunk, with all its towers and battlements; and its site was instantly filled with water."*

Along this line we have also many of the observable changes of level in Scandinavia, the particulars of which are so ably discussed by Sir Charles Lyell.†

The force exerted along this line seems to have occasioned the dislocations which give rise to the numerous cataracts and picturesque scenery found in that country; as well as to the submergence in Denmark, at some period, of the forest on which Hamburg

* Mrs. Jamieson's Europe, p. 171.

† Lyell's Principles, Lond. Ed. of 1850, pp. 186, 499, 541.

and its harbor are constructed;* and probably also to the subsidence of land in Scania.†

Thence passing through the heart of Germany, it may cause the northerly and southerly direction of the Weser, the Ems, and the Rhine, as well as of the Black-Forest Mountains; it may have produced the dislocation which forms the Falls of Schaffhausen, by raising the land around the basin of Lake Constance, near which the Danube takes its origin. Passing near the Rossberg, the internal forces, acting externally along this great circle, probably produced the southerly fall of that mountain's apex, as lately as 1806; and may have aided in constructing the basins of the twenty-two beautiful lakes, (I think that is the number which can be seen from the summit of the not far distant Rigi,) inasmuch as every elevation is likely to take place at the expense of adjoining land, thereby producing depressions; and the same internal force may promote the causes which bring to the surface the hot water of Pfeffers' Baths and similar thermal springs, not far from the line we are following.

Continuing our south course a little west of the above baths, we encounter not perhaps the very highest point in Europe, (Mt. Blanc,) although several points about second in height, Rosa, the Jungfrau, etc., are not far off; but we find the highest land ridge, the Furca, Pass, between the Grimsel and St. Gotthard, the central point already mentioned, whence flow the Aar, the Reuss, the Rhine, the Rhone, the Tessino, etc.

Thence, passing near Genoa, our Alpine Great Circle leaves the Island of Corsica (which bears marks of great disturbance at some period, having on it scarcely any level land) and the Island of Sardinia as regular in their due north and south direction as Denmark, while the lands on each side, Italy and Spain, bear evidence of having been forced from a median line. Under this influence, probably, Monte Nuovo came in a few hours to the surface, the Temple of Jupiter Serapis, etc., etc., were alternately raised and lowered;‡ and Graham's Island was elevated from a depth of one hundred fathoms water.§

Between the Tropic of Cancer and the Equator, the force seems

* Woodworth's Youth's Cabinet, for November, 1856.

† Lyell's Principles, p. 509. ‡ Ibid, p. 489. § Ibid, p. 416.

to have been inadequate to produce much impression on the northern parts of Africa, or was overcome by lateral force; but perhaps the vertical again exerts an influence on the coast of Lower Guinea, and also among the Friendly Islands of the Pacific, besides producing the recent upheavals of land among the Aleutian or Fox Islands.

This great circle, along the plane of which a powerful force seems to have acted from the interior, (as stated above and enlarged upon more hereafter,) sometimes elevating and sometimes depressing the crust, is called in the definition, for the sake of brevity, "the Alpine Median Line." It might be appropriately named the Pacifico-Alpine or Pacifico-European Plane of Force.

We next follow the other great circle in a vertical plane, at right angles to the vertical plane just described. The plane now to be traced by its great circle, is defined the American or Ando-Siberian; it might, however, be named the Indo-American or Himalayo-Andean Plane of Force. It passes in or about 82° or 85° W. of Greenwich, (consequently 5° to 8° W. of Washington, and about 90°, or thereby, west of the Alpine Median Line,) through Hudson's and James' Bay. It probably elevated Lake Erie above Lake Ontario, giving rise, with subsequent aiding causes of disintegration, to the Falls of Niagara, as well as to minor falls, causing the great bends in the Ohio between Wheeling and Cincinnati, the Silurian upheavals (of which Cincinnati and Nashville form nearly the anticlinal axis) displacing the Michigan coal-field, forming dividing ridges for waters, perhaps submerging the Mammalia in the swamps of Big Bone Lick; producing gaps in the mountains, and bringing up innumerable hot and sulphur springs, which had drained through the coal regions, springing into arches, particularly in the limestone regions, extensive intercommunicating caverns and natural underground galleries, of which the Mammoth Cave is the centre, (while the caves of Corydon, Clarksville, Nashville, etc., etc., are probably branches;) forming besides the channel for subterranean rivers, such as one struck lately in Artesian boring, near Henderson, Ky.

In this connection it may be well to remind the reader, that on or near the other Median line are found the Malström, the "Perte du Rhône," and formerly the terrific Charybdis, so beautifully alluded to by many of the ancients, and described by Schiller in his poem, "The Diver," (see Appendix,) evidently indi-

cating subterranean cavities of vast extent, into which the water rushes.

Continuing south on our American Median Line, we pass through Central America and touch the west coast of South America, nearly as the Alpine Median Line skirted the coast of Africa, and nearly in the same manner as our American Line, continued through the south pole and followed to the Indian Ocean, touches the west coast of the Birman Peninsula, upheaving the Island of Reguain,* and, passing near the centre of the dividing water-slopes, crosses the Altai Range, and emerges from Asia near the north-east cape, thus following the greatest north and south elongation of Asia, and traversing the Arctic Ocean to reach the north pole.

Before closing this part of the subject, it may be proper to remark that there are other planes, in which the earth's crust seems to have yielded partially, either to an internal expansive power or to the same centrifugal force which has produced the increased equatorial diameter; but as these are less important than the others, I will here make only one more remark on this subject, viz.: that, while the American Line, traced out above, leaves about as much land in North America to its west, as it leaves in South America to its east, and the Alpine Line passes centrally through the Pacific, so two other lines may be found, one passing medianly through North America to the western shores of the Gulf of Mexico, the other passing centrally through South America, upheaving the Pampas Plains and cutting North America about the region of Nova Scotia.

The expansions above detailed, particularly on the first two great planes of elevation, would account for the intermediate sinking of land, observed in Greenland, in the region of the Caspian Sea, of some islands in the Pacific, etc., etc. (See Diagram III., fig. 1.)

We next proceed to examine similar *evidences of dislocation*, alternate expansion and contraction, or upheaval and subsidence *coincident with parallels of latitude.*

Beginning in the Arctic Ocean, we find, in Dr. Kane's narrative of his highly interesting and instructive "Arctic Explorations," detailed proofs† of an axis of oscillation in or near 77° N., with a depression on each side of this line. Again, in or about lat. 45° N.,

* See Johnson's Ph. Atlas, Lea & Blanchard's Ed. of 1850, p. 6.

† Kane's Arctic Explorations, p. 81; also pp. 277 and 278.

we have the Falls of St. Anthony, the Gates of the Rocky Mountains, the Falls of the Columbia River, and other proofs of dislocations, which would occur if one portion of land were raised at the expense of an adjoining part, or while the latter remained stationary; and we have in Europe the Alpine, in Asia the Altai chain.

About the region of the equator we have, of course, as indicated by the greater equatorial diameter, an elevation which must produce depressions on each side, probably in or about the Tropics of Cancer and Capricorn; and, as we know the Pampas Plains are rising, we might infer an axis of oscillation in about lat. 40° or 45° S., and possibly a depression in or about the antarctic circle, with a rise again in lat. 77° or 80° S., as observed by Dr. Kane in the north: thus giving a great wave-crest at about every 45°. (See Diagram III., fig. 2.)

At the same time it must be observed, as the highest mountains in the Western Continent (the Peruvian, Bolivian, and Chilian Andes) and the highest mountains in the Eastern Continent (the Himalayas) are respectively near the Tropics of Capricorn and Cancer, it seems probable that the greatest circumference of the earth might coincide with the plane of the ecliptic, and have been produced by centrifugal force at a period when the northern axis of revolution passed from the region of the arctic circle (perhaps at Behring's Straits, perhaps in or about the American Magnetic North Pole, when it reaches its extreme western elongation) to the neighborhood of the antipodal antarctic circle, its then southern axis.

COMPARISON OF VARIOUS GEOGRAPHIC AND HYDROGRAPHIC MEASUREMENTS.

It has already been remarked by physical geographers that the continents have a somewhat triangular form, with the apex pointing to the south;* but it will be found, in addition, that if 66° 30′ be taken with compasses, tape-line, or other means, on a good-sized globe, and applied in Africa, it will measure its greatest width, viz., from Cape Roxo to Cape Guardafui, and its length, from the Cape of Good Hope due north to the Mediterranean Sea on the coast

* Perhaps it may be admitted, on close examination, that these are rather rhombic in form.

of Tripoli. The same measure applied at Cape Horn extends due north to the nothern limit of South America on the coast of Caraccas; from a point a little south of Florida to the Ter. N. P.; from the Ter. N. P. almost exactly to the Bay of Cambay, as well as to the Bay of Bengal and to the Gulf of Tonquin; from Cape Farewell, the extreme point of Greenland, to Cape Lapatka, the extreme point of Kamtschatka; from Behring's Straits to the Gulf of Tonquin, as well as to the southern shore of the Gulf of Mexico; from the Alps, through the Mag. N. P. to the northern limit of the Rocky Mountains; from the Alps to Behring's Straits, also to the Coromandel Coast and to Kunchinjinga, about the highest of the Himalaya Range; from almost the highest Andes on the equator to the coast of Africa on the Tropic of Cancer, as well as to South Shetland; from the Palestine coast of the Mediterranean, in or about lat. 33 N., (near Lake Gennesaret or Tiberias, formerly the Sea of Galilee,) the same measure extends to the Sea of Okhotsk, also to the Yellow Sea and to Cape Cambodia.

This list might be much more extended, showing that the lines of rupture between great masses of land are apart about 66° 30′, or the complement of 23° 30′. It will probably suffice to add to the enumeration of these measurements that it is the same distance as above, viz., 66½°, from the coast of China at the Tropic of Cancer to the Bass Strait, between Australia and Van Dieman's Land, (Tasmania;) also from the Coromandel coast to the south-western limit of Australia, and from the Sandwich Islands to the north-eastern coast of Australia.

Half this distance (viz., about 33¼°) measures also the interval between a number of important points, as from the Am. M. N. P. to Cape Race in Newfoundland, thence to Cape Sable in Florida, thence to the western coast of Old California, thence equidistant to Aliaska, and again back to the Am. M. N. P.; or with Cape Mendocino, on the California coast, for a centre, and the same distances in our compasses, we sweep from the Am. M. N. P. along the eastern shore of James' Bay, near the Falls of Niagara, and reach the Gulf of Mexico on the west coast of Florida. Then moving the centre to the Straits of Gibraltar, we may curve from Cape Race, in Newfoundland, with the same radius, past Cape Farewell in Greenland, the Malström, the extreme east of the Gulf of Finland, Sea of Azof, coast of Syria, (thus marking the total length of the

Mediterranean,) finally to the Gulf of Guinea. Or, with the Alps for a centre, and the same radius, we pass through Spitzbergen, Nova Zembla, along the whole range of the Ural Mountains and the eastern shore of the Caspian; we touch the Gulf of Persia, Lake Bornou in Africa, and Cape Blanco.

Again, a similar circle, described from Palestine as a centre, sweeps through the Straits of Gibraltar, divides Spain and Portugal, touches the extreme west coast of France, the mountains of Wales, part of Dofrafield Mountains, the northern shores of the Bothnian Gulf, the arctic circle in the White Sea, the western limits of the Himalaya Range, the Gulf of Cutch, and the equator.

This radius also measures the distance from the coast of India to the Straits of Sunda, from Cochin China to Australia, the exact width of Australia on the Tropic of Capricorn, and its extreme vertical length from Torres' Straits to the south of Tasmania, from New Guinea to the Society Islands, from the Sandwich Islands to the Marquesas, to the coast of California, or to the extreme northwest peninsula of America, Aliaska.

Not to weary the reader with similar details, which he can multiply indefinitely at his pleasure, it will suffice to enumerate a few prominent distances spanned by $23\frac{1}{2}°$, and several smaller measurements which seem to be the eighth part of $66\frac{1}{2}°$, or nearly $8\frac{1}{4}°$; near enough at least for practical purposes.

The former of the two measurements, viz., $23\frac{1}{2}°$, will be found to be the distance from the Alps to Palestine, as well as, in a due south direction, to the Tropic of Cancer; also from the Alps successively to the Madeira Islands, to Mount Hecla in Iceland, to near the Malström, to Lake Onega, and to the eastern shore of the Black Sea.

It also measures from Palestine to the Baltic, to the Sea of Aral, to the south coast of Arabia, and to the Gulf of Genoa, and indicates the distance from Africa to the nearest point in South America.

The smaller measure (about $8\frac{1}{4}°$) will be found to reach from the north of Scotland to the British Channel; from the west of Ireland to Flanders; from the west of Scotland to Denmark; from the Malström to the Baltic; from the Baltic to the Adriatic; from Calais to Genoa; from Brest to Marseilles; from Cape Finisterre to Cape

St. Martin in Spain; from Genoa to Etna; from Tunis (ancient Carthage) to Barca; and from the Alps to the Gulf of Tarento.

Passing to the Western Continent, we find it also measuring the distance from the east to the west coast of Hudson's Bay; from Hudson's Bay to the St. Lawrence; from the north-west shore of Lake Superior to the Falls of Niagara; from the Ohio to the Gulf of Mexico; from the mouth of the Mississippi to Yucatan; and from the lower Mississippi to the Atlantic coast in Georgia; it also spans Mexico, on the Tropic of Cancer, and Greenland on the arctic circle.

The next investigation leads us to an examination of the problem noticed in the introduction as the second, viz.:

The different successive geological periods will be found more recent, and less dense in structure, as they leave the north pole, and approach the equator. Although certain layers probably invest the globe, in a succession never inverted, yet, where upheaved, the edges or vertical sections of these formations appear to have been brought to the surface along concentric (or subconcentric) lines, which are parts of great circles, intersecting each other in such a manner as to form equilateral spherical triangles on the earth's surface: each angle of intersection being equidistant from our present north pole; also in such a manner as to cause hypozoic outcroppings in the smaller triangles, palœozoic in the next, and cainozoic in the larger. (See Diagram III., fig. 1.)

After a close investigation of this subject, using the resources within my reach, but possessing few facilities for throwing light on the geology of Australia, China, and Japan, especially regarding the nature of the coal found there, I am compelled to adopt the conclusion that (although the various geological layers usually described may form the earth's crust) a greater amount of the older, more solid, crystalline, hypogene rocks are brought to the surface in high northern latitudes, a predominance of secondary rocks, hypogene as well as sedimentary, in the North Temperate Zone, and Tertiary with later igneous and aqueous formations in the equatorial regions.

Whether the formations south of the Tropic of Capricorn are the most recent of all, (hypogene as well as sedimentary,) or whether there is again an inverted repetition of the formations found in the northern hemisphere, I have not the data accurately to determine;

but incline (from knowing the post-tertiary character given to the Pampean, East Indian, and Central Australian Formations, as well as from deductive reasoning) to the conclusion that the depositions in the southern hemisphere were made more recently, and upheaved to the surface more lately, than those in the northern, and I have therefore laid down the various geological formations, in accordance with these views, on the Map of the World No. 1.

Should the other supposition be correct, it would by no means vitiate the correctness of the map for the formations in the northern hemisphere, nor deprive it of the practical value which I sincerely hope will be attached to it, and even more especially to Map No. 2, in which the outcroppings of these formations, as well as the chief mineral surface-indications, are marked more in detail.

Hoping, as observed above, that a statement of the uniformity and regularity with which the internal treasures of the earth have been brought near its surface, for the benefit of man, by laws emanating from an Omniscient and Beneficent Creator, may prove of value to the practical miner and student of Economic Geology, I propose to dwell somewhat in detail on the endeavor to point out this generalization.

By carefully laying down, on accurate maps, all the prominent points at which the hypogene rocks are found in close proximity to secondary rocks, and the latter again to Tertiary rocks, rejecting a few anomalies which occur chiefly at or near the above described longitudinal lines of upheaval; by carefully noting the chief localities in which coal and the ordinary metals have been found, there seems no doubt that these geological lines of junction and of greatest metalliferous surface-wealth, form, as already stated, equilateral spherical triangles, the three sides of each of which are formed by the intersection of great circles, and the apex of which is to be found very nearly if not quite at the Terrestrial North Pole; it is consequently probably the apex of a nucleiform spherical tetrahedron on the curved faces of which there appear to have accumulated successive layers of deposition. However, whatever the theory may be, the practical result is, that by following the lines indicated on the map we connect nearly all the points at which mineral wealth has thus far been found, and in which ranges therefore we may most reasonably expect again to find it, at intermediate points or on extensions of those lines.

To render the above more intelligible, a map of the world, on Mercator's projection, published in 1856, by Messrs. Colton & Co., New York, was carefully reduced by the lithographers, and is marked in this work, Map No. 1, already referred to; and on it they laid down the successive points forming on the globe these triangles, which, however, on the developed cylinder, form curves. The successive periods have been colored differently, and other details added, which are more fully explained in the descriptions of the plates.

It may be proper to remark that as, at some given depth, every important stratum or geological succession of rocks, as usually enumerated in standard geological works, may be supposed to exist, so at almost any place on the globe a sufficient force may suffice to bring one or all to the surface within a few miles by outcropping, and the above classification into triangles only claims that the *predominant* rocks of each triangular upheaval were, *as a whole*, newer, in any given large triangle, than in the smaller triangles upheaved nearer the north pole; or, *vice versâ*, that the nearer to the north pole any triangular upheaval exists, the older the majority of the contained rocks will be found to be.

The term triangle is used as convenient, because, to the eye situated above the north pole, a horizontal section of the first upheaval would present a triangle; although, strictly speaking, the space enclosed between that triangle and the next upheaval would be formed of three trapezoids, the result of the successive layers of deposition on the original spherical tetrahedral nucleus, along planes coincident with secondary crystallization.

The most interesting practical development for the miner remains yet to be stated, viz.: That the most productive and abundant surface indications of the most useful metals will be found nearly to accord with the crests of the prominent geological upheavals, and will be found especially abundant not far from the termination of the secondary upheaval, or, in other words, not far from the coal—a most fortunate circumstance for fuel facilities near the furnaces. To render this evident, it is only necessary to lay down on the globe or map, from late statistical tables,* the various localities at which a given metal is found. As an example, we will commence with

* Fitch's Outlines of Physical Geography may be used. See pages 207-209.

COPPER.

Beginning a little south of Great Circle B^{I}, we find prolific copper veins at Prince's location, (on the north shore of Lake Superior, sometimes designated as the "Mines of the British North-West Mining Company;) and continuing in a south-east direction, we can trace them to Spar Island in Lake Superior, thence in the clear water trending to Isle Royale, where native copper is abundant, thence in the same direction to Keweenaw Point, (at Eagle Harbor, Ontonagon, etc.,) and afterwards just south of B^{II}, at the Bruce Mines, and in Sweden, etc., as indicated on Map No. 2.

Or commencing at the intersection of C^{I}, C^{II}, in North Alabama, and travelling in a north-easterly direction, we find copper at the Unaka terminus of the Alleghany Range in Polk County, Tennessee; also at Greensboro, in North Carolina; Fauquier County, in Virginia; Liberty and New London, in Maryland; Montgomery and Chester Counties, in Pennsylvania; Flemington, Brunswick, Somerville, etc., in New Jersey; Litchfield, Plymouth, Bristol, and Manchester, in Connecticut; Orange, in Vermont; and Warren, in New Hampshire; also on the Chaudiere River, Canada. We observe that these localities are nearly on the Great Circle C^{II}; and following it into Europe, we find copper in Cornwall and in Germany; as well as in Russia, and Japan, on C^{III}. Returning to the place of beginning, and following Great Circle C^{I}, we find copper also in Arkansas; and perhaps it may be found in Oregon or California.

Outside of this, in the last volcanic wave (the ecliptic in its various positions before settling to rest at the equatorial equilibrium) we find copper on great circles D^{I}, D^{II}, D^{III}, at various points, such as Cuba, Spain, Chili, the East Indies, and Australia.

COAL.

Taking *coal* next, we find just above the crest of the Secondary wave, where it unites with the Tertiary Epoch, the chief coal deposits in the world. Beginning north of Oregon, at Vancouver's Island, and on the Columbia River, in Washington Territory, we find a considerable amount; following a line parallel to, but somewhat north of, Great Circle C^{I}, we encounter the great Iowa and Missouri coal-field, described by my brother, Dr. D. D. Owen, in his quarto

work, entitled "Geological Survey of Wisconsin, Iowa, and Minnesota." Next we find the coal-field of Illinois, Indiana, and Kentucky, abounding, like the former, in the cannel-coal and jet variety; then the coal of northern Alabama, of Tennessee, and of north-west Georgia, at the extremity of the great Appalachian coal-field, rich in bituminous coal about its middle portion and its western extremity; anthracitic in character at its eastern elongation. The small amount found in Massachusetts is of the same character, as well as that of Rhode Island. The Michigan coal-field seems to have been heaved out of place by the Silurian outburst in Ohio, and probably resembles the coal of Kentucky.

Following Great Circle C^{II}, in a north-east direction, we find coal, more rich in the compounds of hydrogen, at New Brunswick, Nova Scotia, and Prince Edward Island.

About the same distance north of C^{II} we find it in the Eastern Continent, in central Ireland, southern Scotland, northern and middle England, in Belgium, southern Sweden, northern France, north-western and south-eastern Germany, Poland, Moldavia, Wallachia; perhaps also on Great Circle C^{III}, about Lake Baikal, and certainly in Japan and part of China.

Outside* of this we find coal, but, so far as I can ascertain, it has more of the lignite or Tertiary coal in its character: it will be found on Great Circle D^{I}, D^{II}, D^{III}, in Chili, around the Persian Gulf, in the East Indies, in China, and in Australia.†

Coal may also be found prior to the true Carboniferous era, probably of a denser and more slaty character, north of Great Circle B^{I}, B^{II}, B^{III}, at Waigat Island,‡ (on the west coast of Greenland,) and on the south-east coast of the White Sea. Regarding the

* When the term "*outside*" is used, it is intended to designate a later formation, occupying a larger triangular upheaval, or the result of a more recent volcanic wave than the formations nearer the north pole.

† Australian coal, according to newspaper statements, resembles anthracite. This requires confirmation. If the report is sustained by Prof. Dana's late work, which I have not had the advantage of seeing, I would account for the fact on the supposition that New Holland, and probably New Zealand, do not now occupy, geographically, the same position as formerly, and indicate geological structure of an earlier date than their position would lead us to expect. The above supposition is confirmed by the fact of the volcanoes being extinct.

‡ See Instructions to Capt. Hartsteen from the Secretary of the Navy, given in Appendix to vol. ii., p. 322, of Dr. Kane's Arctic Exploring Expedition.

details of this latter locality, I am not well informed; but refer the reader to the works of Murchison and Keyserling.

It may here be proper to remark, that the great *Peat* localities are usually adjoining the coal-fields, as in Ireland, Scotland, England, Holland, Switzerland, also north of the United States; and a very similar formation, many feet thick, which, I am informed, is found in the northern portions of North Carolina. The surturbrand of Iceland is probably of similar origin.

The chief mineral wealth—excepting, perhaps, gold, platina, silver, quicksilver, and even these are not uncommon in some countries of Secondary formation—is to be found just at the outside of the true coal near the junction of the Secondary and Tertiary waves. As a proof I may cite the *zinc* of New York and New Hampshire, of Pennsylvania, New Jersey, Missouri, Iowa, Wisconsin,* and Tennessee; of Belgium, Prussia, Poland, Altai Mountains, and China; *tin* in England, Spain, Germany, Bohemia, Galicia, Ceylon, the Malay Peninsula, Birmah, China, etc.; also the manganese, cobalt, antimony, bismuth, etc., obtained in Germany, parts of China, etc.

The same holds good of many *salts*. Beginning with common salt, we find it just outside or inside of the coal, viz.: sometimes in the Palœozoic Rocks, more frequently, however, in the mesozoic Saliferous Period. Thus, in the United States, the saline springs of celebrated watering-places are from Lower Silurian Strata; the salt of Onondaga County, New York, is from Upper Silurian, that of Virginia is in the Carboniferous, while in England it is in the New Red Sandstone; in Switzerland it is in the Lias; in the Carpathian Alps in upper Oölite; but in Poland it is in the Cretaceous Formation.

Perhaps the greatest saline deposits are in the Tertiary, impregnating also the inland lakes. Thus we have, south of Great Circle C^{I}, the Great Salt Lake and salt desert of Utah; south of Great Circle C^{II}, the Rock-salt Mountains of Spain and the saline Dead Sea; south of Great Circle C^{III}, the Rock-salt and salt desert of Persia, and the saline lakes Caspian and Aral, besides the deposits in Northern Africa.

Nitre is plentiful in Hungary, sal ammoniac in Sicily, etc., etc.

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* The calamine ("dry bone" of the miners) or carbonate of zinc, found abundantly in the lead ores of the Western States. See Dana's Handb. of Min., p. 255.

THERMAL SPRINGS; ALSO MINERAL SPRINGS GENERALLY.

These, being abundant about the close of the Secondary Period, may next engage our attention. Although a few, as the Geysers of Iceland and the sulphuretted hydrogen springs of the Middle States, are found near the beginning of the Secondary Period, we readily perceive, as above stated, that they are most abundant at its close, particularly when we recall to mind the Arkansas hot-springs, the numerous springs in Virginia, as well as those of England and Germany, Switzerland, Northern Italy, Turkey, etc.; the details of which can be found in any work on Physical Geography. They seem to result chiefly from draining through the coal, thus becoming impregnated with sulphur, iron, etc.

BITUMINOUS PRODUCTS.

These also are most abundant at this period, as we might naturally expect. The heat and natural drainage have converted the coal in the higher regions of the Alleghanies into anthracite, (depriving it of its bitumen,) and have so impregnated the rocks in Virginia and other surrounding areas with these drainings, that we have the Naphthas, the Seneca oil, the British oil, the mountain oil, (Bergoel of the Germans,) petroleum or mineral tar, etc., welling forth from the rocks. The lighter and more volatile carbo-hydrogenous oils, the benzole, etc., with its gaseous products and more solid paraffine, are commoner in the western coal-beds approaching to cannel-coal in character. So also in the *light* coal of Nova Scotia and part of Scotland. In England, where the coal is heavier, these bituminous products are also found just at the outer edge of the coal-field, and the same is doubtless the case in Germany, Switzerland, northern Italy, Persia, and especially in the Birman Empire.

The collections of the more *solid* "elastic bitumen," chiefly found on the surface of lakes, are outside of the Secondary wave-crest, as at the Dead Sea and in the region of the Euphrates; also in the Islands of Barbadoes and Trinidad. This bitumen results, probably, from the evaporation of the more liquid parts.

Amber, the fossilized resin of trees, going to form coal-fields, is also found frequently outside the ranges of the great coal-fields, in the Tertiary. As it often encloses insects, it no doubt exuded, in a semi-fluid state, under less pressure and heat than when bitumized.

In this connection also may be mentioned, that where iron (the localities of which will be alluded to hereafter) comes in contact with coal under peculiar circumstances, probably of heat, etc., we have graphite, the so-called black-lead used for pencils, as in New Hampshire and in Massachusetts; also at Cumberland, England; and in Prussia, etc.

Perhaps I have not collected sufficient facts to establish the next point I propose bringing up; but I offer some few for further observations and additions.

SILEX.

Silex is undoubtedly abundant in some Tertiary countries, as southern California, portions of New Mexico, Mexico, Africa, Persia, etc.; and it seems to be produced, in its crystalline varieties of the quartz family, vitreous, chalcedonic, and jaspery, (as rock-crystal, amethyst, agate, flint, jasper, etc.,) near this crest of junction between the Secondary and Tertiary formations. Thus we have splendid forms of rock-crystal near the Arkansas hot-springs, also fine rock-crystal and agates among the Alps of Switzerland, (late Secondary,) and flint deposited around some nucleiform organism in the chalk period. True we find Quartz crystals also at the previous wave-crest, B^{I}, B^{II}, B^{III}, as at Prince's Copper Mines, on Lake Superior, and in some of the New England States; also, as siliceous sinter, at the Geysers in Iceland, and elsewhere; but not so abundantly as later.

Our millstone grits, too, are in the Carboniferous era, in Indiana, Ohio, France, etc.; and the silicious carbonate of lime is found at Fontainebleau.

WHETSTONES, NOVACULITES, ETC., (SILICATES OF ALUMINA.)

Where this silex comes in contact with alumina, under the influence of igneous action, as about the junction of the Secondary and Tertiary waves, we have also good materials for honing edge-tools. Thus the Washita stone, the North Carolina and Georgia Novaculite, and the Turkey oil-stone, are perhaps among the finest of that character.

It also strikes me that the best porcelain clays, the decomposing felspar (Kaolin, etc.) are found at the close of the Secondary, as the fine clay of Missouri, United States, (near Herculaneum;) that

of Wilmington, Delaware, and some Eastern States, where good white stone-china is manufactured; that of Cornwall, Staffordshire, etc., in England; of Limoges, in France; of Luxembourg, Trier, and Saxony, in Germany; and, best of all, the extensive deposits in China.

But we must pass outside of this into the Tertiary of Texas, of northern Mexico, of some of the Eastern United States, also of southern France, of southern Germany, of Italy, Greece, Asia Minor, etc., etc., to find the sulphates of lime, (large deposits of gypsum;) also the carbonates of lime, (marble of Carrara, Paros, Corsica, Scio, Samos, and Lesbos; calcareous tufas of Mexico and elsewhere; and the travertino of Tivoli, etc.)

Still later in the Tertiary we must look for the native metals, particularly the precious metals, and for the gems.

It is true, gold is found somewhat abundantly in the Carolinas, in Virginia, etc.; also, gold, silver, and quicksilver abound in Mexico, in Spain, Austria, etc.; but the most abundant product of the above metals, in their virgin state, will undoubtedly best repay the laborer's toil in the Sierra Nevada of California, in New Mexico, in the Andes, in Africa, in Australia, and in eastern Siberia. Platina has been found in North Carolina, in St. Domingo, and in Borneo, but is most abundant, with its attendant metals, iridium, rhodium, palladium, and osmium, in South America, and in the Ural Mountains of Russia.

Alumina, crystallized, with some aid from silica and the alkalies, into the beautiful gems of nearly pure clay, as sapphire, oriental ruby, corundum, topaz, kyanite, etc., as well as pure *carbon*, crystallized, (the diamond,) are also found in or near this last great volcanic wave, being abundant in Brazil, in India, Ceylon, etc., the accompaniments, with the metals, of powerful recent volcanic evidences on a great circle, extending from Behring's Straits along the Sierra Nevada, the Andes, Borneo, eastern Asia, Kamtschatka, etc., back to Behring's Straits; on which circle volcanoes or earthquakes are almost of monthly occurrence.

The aluminous carbonate of lime (water limestone) is found in the New York Upper Silurian and in the Louisville (Kentucky) Devonian Formations; while fluate of lime (fluor spar) usually accompanies the lead ores, and is hence called by the miners "lead blossom."

If we desire to find magnesian minerals and rocks, (talc, soapstone or steatite, chlorite, magnesian carbonate of lime or dolomite, etc., etc.,) we must, on the contrary, go back to an earlier part of the Secondary, and we find dolomite, the lead-bearing rock in Iowa, Wisconsin, and Illinois; from New York, Massachusetts, Vermont, and New Hampshire we obtain talc and soapstones; or we pass to England, Scotland, Sweden, Tyrol, etc., for the more compact serpentines; or finally, when the serpentine has mingled with some limestone, we recognize it as the beautiful verd-antique in the quarries of Italy.

Thus I might go on, through a volume, enumerating facts all tending, I think, to prove the generalization stated, that the chief mineral wealth has been brought to the surface according to fixed laws and along regular lines, readily traceable. I will only mention one or two more.

LEAD.

Thus *lead* can be traced from Iowa, Wisconsin, and Illinois, to Missouri, south Illinois, Kentucky, Tennessee, and probably elsewhere in the United States, as well as in Great Britain, Belgium, Germany, etc., etc. *Arsenic* is frequently associated with lead.

GOLD.

Gold may be found near this wave-crest, among the Carolinian, Georgian, and Virginian Alleghanies; as well as in Spain, Austria, the Ural Mountains, etc.; but it is collected much more abundantly in a later upheaval, as already stated, as the Sierra Nevada of California, the Andes of South America, Central Africa, south-eastern Australia, and eastern Asia.

But enough has probably been said to enable the reader to perform this work for himself, with the aid of statistical tables of localities, to be found in Dana's Manual of Mineralogy, or in Fitch's Physical Atlas.

I now propose, therefore, to close this chapter by glancing rapidly at a few more proofs of parallelism between the two continents, both as regards external structure and the mineral contents, which resemblance the reader has probably already perceived.

In the north of both continents we have a very large bay or sea, not very salt, numerous fresh-water lakes, and the land generally is cut up into numerous islands, with bays and inlets.

Hudson's Bay corresponds to the Baltic; the Lakes Winnepeg, Athabasca, Great Slave, and Great Bear, to Lakes Ladoga and Onega.

In the Western Continent, however, it will be observed, all is on a larger scale, the land being especially more elongated north and south than in the Eastern Continent.

The Gulf of Mexico (with its Caribbean Sea) corresponds to the Mediterranean, except that the current sets *out* of the former, and the *surface* current, at least, *into* the latter. We have Mexico corresponding to Spain, Florida to Italy; the West Indies to Sicily and the Grecian Archipelago; the Isthmus of Panama to the Isthmus of Suez.

South America corresponds to Africa: the American Median Line passing through Hudson's Bay and touching South America on its west coast at the equator; while the Alpine Median Line passes through the region of the Baltic and leaves Africa to its east, also just touching the west coast at the equator.

The great circles, intersecting each other, enclose between them, in both cases, trapezium-shaped continents.

In both continents we have large central rivers emptying themselves, their tributaries, and their detritus into the large central gulf or sea; while smaller streams, from near the sources of these others, carry a portion of the circulating waters to northern and southern regions.

The strong resemblance in the Rock Formation and in the mineral products has already been partly pointed out, and may here be shortly repeated, thus: In arctic America and in arctic Europe we have compact crystalline rocks, of an early age, granites and syenites. A little farther south we have, in both continents, numerous metamorphic rocks, slates, schists, etc., as the gneiss, mica slates, etc., of Labrador, Greenland, Norway, and Sweden. Coming to the region just north of Lake Superior, about B^{I}, B^{II}, etc., we have Ancient Volcanic Rocks, in the form of numerous ancient amygdaloids and of basaltic causeways, similar to those south of B^{II}, afterwards found in northern Ireland, that cover nearly the whole of Antrim;* and also the beautiful colonnades of Fingal's Cave, as well as the Porphyry and Trap of northern Scotland; accom-

* Colton's folio Atlas, vol. ii.; Ireland, No. 1.

panied, somewhat later, by secondary deposits; and still farther south we have less compact Igneous Rocks, with recent volcanoes, and less solid sedimentary deposits, whether of rock, soil, marl, or sand.

The parallelism of the coal, copper, lead, and other localities has been already dwelt upon somewhat in detail, as well as of salt and salt deserts, of gypsum and of clays and of limestones.

Of iron I would here only remark that, although, fortunately for mankind, it is widely diffused over the globe, perhaps some of the purest and best will be found not far from the Americo-Asiatic and the Alpine Pacific great circles: thus we have in America excellent varieties of specular iron ore,* or sometimes the hematite, from New Hampshire, Massachusetts, Vermont, New York, Iowa, Wisconsin, Maryland, Virginia, the Carolinas, but particularly from Pennsylvania, Missouri, and Tennessee; while other varieties are found in Maine, Connecticut, New Jersey, and Rhode Island, and again at the antipodal portion of the circle in the Birman Empire and elsewhere in Asia.

In Europe we have fine iron ores in Norway and Sweden, in the Shetland Islands, Scotland, and England, in Belgium, in France, Switzerland, Bavaria, Silesia, Bohemia, the Hartz Mountains, Styria, and Carinthia; in Spain, Italy, and Elba; much more rarely, however, I think, in the southern hemisphere, if we except anomalous Australia, which, as already stated, is probably not *in situ.*

In finally closing this chapter, I shall only briefly allude to the fact of an apparent repetition or duplication in *Asia* of the structures, minerals, etc., pointed out in Europe and in America, as well as also in external configuration, showing the tendency in nature to bilateral structure. Thus we have east of the Ural Mountains, in Siberia, the great plains, boulders and alluvium, which we find west of the same range in Scandinavia and Russia; we have the Cossacks of the west and the Tartars of the east; the Carpathian and Caucasian ranges matching Hindoo Coosh and Himalaya; Great Britain offsetting Japan, France opposed to China, the Peninsula of Spain and Portugal matching the Peninsula of Birmah and Siam; while Africa is imperfectly counterbalanced by Australasia, with Malaysia.

* See Dana's Manual of Mineralogy, (1855,) p. 219, et seq.

Or, comparing Asia with America, we have in the north of both continents the Drift; in the great central valley of North America large prairies matching the great Steppes, the western Rocky Mountain ranges to represent the eastern Asiatic mountains, Florida and the West India Islands to offset the Peninsula of Malay with its Islands of Malaysia. Farther south we have the Andes bringing up similar mineral wealth to that found in the "Warragongs" or Alps of Australia; the extensive post-pliocene plains of Pampean formation, with gigantic mammalian remains, corresponding with the great central deposits of Australia, containing bones of the extinct struthious giant-birds; we have farther, Tierra del Fuego, representing Tasmania; and the Falkland Islands, the epitomized counterpart of New Zealand.

Hoping the reader considers the first problem, if not wholly, at least partially, demonstrated, it is proposed now to examine, in another chapter, the *causes* of these physical phenomena.

CHAPTER II.

Dynamical Geology: showing the ultimate forces supposed to have given to the earth its present form, and to be connected with the observable electrical and magnetic phenomena.

HAVING endeavored, in Chapter I., to point out some of the most prominent physical changes which the earth seems to have undergone, (judging chiefly from the different geological structures exhibited on its surface, and also from the dislocations, upheavals, etc., indicated by waterfalls, chasms, caverns, and river-courses, besides noting many other phenomena connected with physical geography,) we now proceed to examine what the forces were which appear to have given origin to these changes.

In pursuing our investigations upon this subject, it may be well,

1st. To examine what was probably the appearance of the earth before it was modified by various agencies: in short, what was its nucleiform condition.

2d. To trace the changes, from that condition, towards final development.

3d. To show what were the *immediate* and *remote* agents effecting these changes.

It is, perhaps, not absolutely demanded, as Sir Charles Lyell remarks, that the geologist, in describing the changes which the earth's crust has undergone, should account for its primitive condition, (any more than the historian, in giving the facts regarding the rise, progress, and fall of portions of the human race, is required to account for man's origin;) still, as it is an interesting subject of investigation, and may prove useful, it is proposed here to give

briefly some facts that may throw light on that as well as on later investigations.

Doubtless the Almighty fiat could readily have called every thing instantaneously into the existing state of things which we now see surrounding us. But, as far as our finite capacities enable us to judge, it seems more probable that the Creator has chosen to establish certain immutable laws, by which constantly-acting and sometimes almost imperceptible causes gradually modify and finally change the structure and materials of the earth, as well as of the whole universe; sudden convulsions, dependent, probably, upon the same laws, (an *accumulation*, perhaps, of the same forces,) only *occasionally* diversify the scene, producing catastrophes calculated to remind man of the uncertain tenure of his existence, and to cause him to bow in reverential adoration before the omnipotence of an omnipresent Creator. Let us then, following out Axiom V., that there is probably a general plan in this, as well as other portions of the Creator's works, and admitting also Axiom VI., that the earth, at some former period, presented a smaller superficies than it does now, use our best judgment, applied analytically and analogically, to say what that original form and material *may* have been.

The great La Place believed that the earth and other planets were detached portions of the same nebular materials, the central aggregation of which now forms our sun, around which they revolve; and that the various belts and moons were smaller detached portions, revolving around their central planets.

It does not conflict with this ingenious hypothesis for us to imagine that all these planetary bodies did not fall into their present orbits, and with their present secondaries around them, at one and the same period; nor does it conflict with his very probable supposition, that we should consider those bodies as presenting very different appearances and stages of consolidation, etc., on account of varying circumstances, such as their greater or less proximity to the sun, or their exposure to its direct influence.

Our whole solar system, therefore, *may*, consistently with the above, be the result of a nebular emanation from some central system, around which it revolves; our planets may be portional bodies, detached at different periods from our great central sun,

and the moons be emanations of varied, perhaps regular, periods, from their own proper planets.

Judging of the form which the earth's nucleus assumed from the surface indications alluded to in Chapter I., and admitting, as then laid down, that the geological formations of different ages were brought up in concentric equilateral spherical triangles, we are forced to the conclusion that the nucleus must have had a solid form which could give rise to these curved surfaces, and hence must have been, *probably*, a spherical tetrahedron,* or, *possibly*, two such, placed base to base, forming double pyramids, with spherical faces. Granting this form to the nucleus, we next examine of what it was probably composed at that period.

The central crystallization of the materials forming the earliest hypogene rocks, chiefly granitic, (as well, indeed, as some much later,) comprises the homogeneous minerals, quartz, felspar, and mica. These minerals chiefly consist of silica, less alumina, potash, and some water; besides, in the two latter, lime and peroxyd of iron, and in the last (mica) there is a little oxyd of manganese, and a trace of lithia and of fluoric acid, (Dana.) These materials must of course have arranged themselves according to the laws of affinity, modified perhaps by proximity, and by the magnetic effect of the sun on some bodies and its diamagnetic effect on others, etc. Thus the oxygen, if free, would readily combine with the silicon,† the aluminum, the hydrogen, the potassium, the calcium, the iron, the manganese, and the lithium, (for we find all of these bodies at present naturally combined, and most of them in very great abundance,) and some of the hydrogen might easily unite with the fluorine, a substance supposed to resemble oxygen, as it does not unite with it.

It is true, potassium, in its pure metallic state, is so readily fused that we might be astonished to find it consolidated so early; but after its vaporous union with oxygen, for which it has such intense affinity, there would be no difficulty, so soon as the temperature of

* Prof. Dana considers the tetrahedron a derivative from the cube. (Manual of Mineralogy, p. 37.)

† Silica is found abundantly, in solution, in the hot water of the Geysers, in Iceland. It will be remembered that silex (silicic acid) is insoluble in all acids, except in hydrofluoric, but is soluble in boiling solutions of pure alkalies and alkaline carbonates.

the crust fell below 212° F., in its liquefaction from vapor; while pure manganese and iron fuse at so high a temperature (perhaps about 3000° F., cast-iron fusing at 2700° F.) as to consolidate readily by a small diminution, according to Axiom XVII.

To the above simple minerals were next added, in Syenite and other Plutonic Rocks, the mineral hornblende, (composed of no additional new material, but only different proportions of some of the above,) black tourmaline, or schorl, (composed of the same, with the addition of some boracic acid and soda,) and the Plutonic porphyries, composed very generally of felspar, although sometimes of quartz, imbedded in a base which is not unfrequently felspar itself. If we examine analytical exhibits of the above minerals, we find we have thus only soda (to which the same reasoning applies that was used above regarding potash) and boracic acid, of which the basis (boron) closely resembles silicon, to add to our former list.

Among the *Ancient Volcanic Rocks*, we find chiefly the two minerals felspar and hornblende, (forming the earthy porphyries, as well as basalt, greenstone, serpentine rock, diallage rock, ancient amygdaloids, etc.;) consequently nothing new, (even in the accompanying minerals, serpentine, diallage, chrysolite or olivine, leucite, laumonite, etc., for the augite is merely the dimorphous form of hornblende,) except, indeed, in serpentine a trace of carbonic acid, and in basalt we find, mingled with the iron, a metal, titanium, fusible only before the oxyhydrogen blowpipe.

On examination of the *Modern Volcanic Rocks*, we find exactly such materials as are now *probably held* in fusion below the earth's crust, and *certainly sent* frequently to the surface in a molten condition; even then requiring a century or more under some circumstances, although forming the external crust, to cool down to the temperature of the surrounding medium. These materials (as lava, pumice, pearlstone, and obsidian) are chiefly felspathic; with them we also find abundantly, sulphur.

In the metamorphic rocks (gneiss, mica slate, clay slate, hornblende slate, talcous slate, chlorite slate, hypogene limestone and quartzite) we have no new elements added to those above enumerated. It is true, we find imbedded sometimes in these early hypogene rocks such minerals as emerald, topaz, corundum, zircon, fluorspar, garnet, tourmaline, epidote, yttrocerite, etc., but these would only add five not readily fused metals to our list, viz., glucinum,

zirconium and chromium, cerium and yttrium. The more common metallic veins found in granitic fissures, such as galena, zinc blende, antimony, cobalt, nickel, arsenic, bismuth, tungsten, etc., may have been, and probably were, injected at later periods.

To recapitulate, then, we perceive that up to the time of the deposition of aqueous materials unaltered by igneous action, the only elements important and abundant entering into the composition of minerals and rocks, were oxygen, silicon, aluminum, calcium, magnesium, iron, manganese, potassium, and sodium.

It is true that, as probably all the sedimentary or aqueous rocks result from the wearing away of the igneous, and are consequently of the same materials, all the minerals may be said to originate in the igneous. Nevertheless, some or even many minerals may be the immediate result of infiltration into cavities, segregations from solutions. At all events, we must admit that the elements above enumerated are most frequently found among the earlier rocks, and it is not until a later period that we find the acids abundant, giving rise with these bases to salts; about the same period the powerful element chlorine may have come into competition with oxygen.

It will immediately strike us as consistent with known laws, that oxygen, the most highly electro-negative body, should readily unite with cerium, zirconium, yttrium, glucinum, magnesium, calcium, sodium, potassium, some among the most highly electro-positive bodies, and even with iron and manganese, still tending towards the same; but the union of oxygen with silicon is less in accordance with the above; the great affinity which we know does exist may be due, however, to katalysis, or other influences not yet fully understood.

Having thus endeavored to give some idea of the manner in which the igneous materials of the earth's nucleus arranged themselves in accordance chiefly with the known laws of chemical affinity, and referring the reader to Diagram I. as exhibiting approximately the form of the land (probably however entirely submerged, a circumstance not designed to be indicated on the map) before expanding into its present proportions, the next step, as laid down at the beginning of the chapter, is,

Secondly. To trace the changes which the earth gradually underwent from its earliest to its present form, chemically, geologically, and geographically.

Supposing the above-described nucleus now cooled below the boiling point of water, the union of oxygen and hydrogen, up to this time only vapor, but now condensed into water, would furnish ample materials for a circumambient liquid, especially at the points farthest from the sun, dissolving at the same time various saline products, as chloride of sodium, etc., and even before that period the mixture of oxygen with nitrogen, aided by a portion of carbonic acid, ($\frac{1}{1000}$,) forming an atmosphere around the nucleus, would tend to prevent the further escape of gaseous bodies.

The earth's crust soon after this period would be as readily adapted, as the new volcanic islands we see upheaved, for the reception of the simplest and earliest organic life, the microscopic infusoria of Ehrenberg,* and these, in their turn, by decomposition, might soon prepare the earth for the existence not only of the larger vegetation, and for the simpler radiates, mollusks, and articulates, but even soon for some of the lowest cartilaginous fishes and other animals, adapted for submarine existence at various oceanic depths, such as Professor Forbes has shown to enliven our present seas and oceans.

If the axis of the earth was ever (as some suppose) perpendicular to the plane of its orbit, and if the earth at that period was somewhat like our moon, having either no revolution on its axis, or only revolving once for one revolution in her orbit, thus presenting constantly the same side to the sun, and if the then equator, corresponding with our ecliptic in some one of its positions, passed from about the region of Central Africa, through our present equator near Chimborazo, in the Western Continent, and near Sumatra in the Eastern Continent, back to Central Africa, then we may imagine, in the now temperate zones of the Secondary period, a powerful growth of tropical plants and trees, well calculated, under such solar influence, for the elaboration of carbon to the estimated amount of 40 to 60 per cent. from the atmosphere, and also probably, from its alkaline solution in water, in such additional quantity as, together with the oxygen and hydrogen, would suffice to consolidate into ample supplies of woody fibre (lignin) in the heart-

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* As in the lava of Vesuvius. See Lyell's Principles, page 372; also, the numerous infusorial organisms stated to have been observed in the Antarctic Continent, discovered by our gallant Captain Wilkes.

wood (duramen) of vegetation, after the evaporation of the more fluid materials from the cellulose of the white external sapwood, (alburnum.)

The subsequent decay and subsidence of this vegetation, where it grew, (or sometimes of the same materials transported long distances by aqueous action,) furnished doubtless the vast beds or layers of coal, by the escape of the oxygen with a portion of the carbon, under the form of carbonic acid, the result of chemical action: a decomposition and recomposition (probably an eremacausis or slow terrestrial combustion) which has so completely deprived the coal-naphtha (a substance not to be confounded with wood-naphtha) of its oxygen, that we employ the former for the safe keeping of potassium, when we could by no means employ the latter. Hence, perhaps, too, one source of the evolved carbonic acid found in certain caves near bituminous coal-fields, and also of the ejected hydrocarbons, carburetted hydrogen, oils, bitumens, etc., when even these ingredients are driven off (or forced into adjoining rocks) by greater consolidation and heat, leaving only the anthracitic carbon, the natural terrestrial coke: just as we have in our artificial gas-works the gaseous products in the gasometer, the coal-tar in the intermediate vessels, and the coke left in the iron retorts.

These chemical changes are also imagined to be one means of keeping up the uniform terrestrial temperature found at depths uninfluenced by solar rays, becoming more intense as we descend towards the original igneous and probably yet molten materials.

The atmosphere now surrounding the earth's crust, as above stated, condensing occasionally, when reduced in temperature, into refreshing showers, would, in a long course of years, carry an immense amount of detritus, partly by mechanical, partly by chemical solution, from these early igneous rocks, and deposit them on the lowest portions, which, if there was an upheaval of the refrigerated, solid, and more resisting, polar portion of the nucleus, would, according to Axiom VI., cause the deposition of these sedimentary materials on the gradually hardening sphere-cover, while the undulatory flow of the formative fluid (later volcanic products) would still take place, especially near the equatorial regions, sending its gaseous and fluid materials occasionally through the crust, either at a natural vent, or creating for itself new fissures with convulsive tremors and earthquakes.

This change in the position of materials would, after a lapse of time, so alter the centre of gravity of the mass, attracted to the sun according to the greater or less density of its structure, as perhaps gradually, or suddenly, (most probably the former,) to alter the axis of revolution. This would, at the same time, change the relative position of sea and land, especially if, as is supposed, the internal forces were sufficient to attenuate the crust, increasing its total equatorial diameter, separating the more solid mountain masses and continents by extension of the intermediate plastic materials, producing thereby wide channels such as the Atlantic, into which the waters flowed, most likely at the final convulsive shocks, which happened in the later periods, and overwhelmed the dry land by outpourings similar to those of the last deluge, emanating after the creation of man, from the region of the Mediterranean, of which we shall speak more fully hereafter.

Previous, however, to this period, as new portions of the earth's crust became gradually covered with depositions, (derived, as before stated, partly from aqueous-collected materials, and partly from the atmosphere,) and as that crust, by expansion of the igneous undulatory formative fluid beneath, became upheaved above the waters, under which it was previously submerged, it then first was adapted for the existence of air-breathing reptiles, as well as of some aquatic birds, whose tracks (found in the new red sandstone of Connecticut, U. S.) are of the same age with those of the gigantic batrachians, found fossil near Hildburghausen, in Saxony, and somewhat later than the depressions in the shale of Cape Breton: indicating even the direction of an antediluvian shower of rain, and consequently of the wind, during some portion of pre-Adamite life.

As this *secondary* period closes, with its infinite numbers of infusoria, foramenifera, echinites, and chambered mollusks, so abundant in the cretaceous epoch, it brings us (after such a period of repose as seemed to supervene on each cataclysm) to the *tertiary*, and we encounter cetacean mammalia, the lowest of the class, and, afterwards, other orders, including animals most useful to man, from their adaptation for domestic life and geographical diffusion. These tenanted the globe until later catastrophes of submergence, igneous outbursts, etc., reduced them, as such had done with many preceding genera, to an extinction only preserved in Nature's fossil typo-

graphy, or represented by some few remaining species. Thus, to mention only a few instances, we find the Terebratula and Lingula, of Silurian and other seas, now living in the Mediterranean; (see Appendix;) we have the Nautilus Pompilius of tropical oceans, reminding us of its compeers, the Nautilidæ and Ammonitidæ, (see Appendix;) and also the elephants of Asia and Africa, commemorating their antecedent prototypes, namely, the mammoth, belonging to the same genus, elephas; and the mastodon, the yet more gigantic representative of the same proboscidean family.

Possibly, during some of these convulsions, if the pent-up materials under the earth's crust ever expanded with a sufficient force, (and I leave it for astronomers and mathematicians to calculate how many times greater it would have to be than that of gunpowder when expelling a cannon-ball from its brazen prison,) the sporadic nucleus of our present moon *may* have been thrown off from the region of the Mediterranean, beyond the limit which would compel it to return according to the laws of attraction, and yet only to that orbit of equilibrium where, balanced between centripetal and centrifugal force, it is still near enough to modify the flux and reflux of our oceanic floods.

When these numerous changes of density and separation of plastic surface crust, etc., had brought the axis of revolution to its present obliquity with reference to the orbital ellipse, and thereby given to the earth its present variety of seasons, it was then fully adapted for the abode of man; and he might have enjoyed a life of innocence and happiness in those genial climes under which the Almighty breath called him into existence. But his proneness to yield to the promptings of his baser propensities, instead of to the dictates of God-inspired impulses, subjected him to a catastrophe which, but for the benevolence of his Omnipotent Creator, would have totally exterminated him from the face of this fair earth. He, in His infinite wisdom and justice, has vouchsafed to man a more lengthened period, to show whether he rightly estimates the blessings showered upon him.

The fossil remains of man are found only in the most recent tufaceous limestone, such as that now forming in the West Indian Island of Guadaloupe, similar in character to the limestone hewed by the Mexican with a broadaxe, when first quarried, and afterwards,

as the aqueous materials evaporate, forming a solid and substantial building-stone. Much more might be added in this connection, but it is time to pass to the next consideration—

Thirdly. What were the ultimate forces which gave rise to these changes just enumerated?

Undoubtedly the sun was and is the chief, if not the only source which gives rise to motion, in all its forms, undulatory, vibratory, frictional, irritant, etc.; and under its various modifications and titles of heat, light, electricity, magnetism, disturbed equilibrium, stimulus, etc.

This may be true regarding the *remote* cause, under any theory of *immediate* causes: thus it may be true, whether we imagine the immediate effect to arise from the different temperature communicated to the metals, inducing thermo-electrical currents, and consequent chemical action; or whether we imagine the oxygen near the poles,* by a difference in temperature, rendered magnetic, and other substances, nearer the equator, diamagnetics; or whether we imagine that the sun keeps up through the luminiferous ether and thence through our atmosphere a vibratory communication, which in the form of light and heat vivifies and stimulates to action not only organic bodies, but even inorganic elements. Two gases may thus be mingled in the dark without any effect, when a single ray of vibratory light, or an electrical spark, would unite them with explosive violence, forming a new chemical body.†

The great sources of electrical disturbance are friction and chemical action. Perhaps even the latter may be in some measure due to the former. *Friction*, of course, must arise whenever there is motion among the particles of matter; more, however, when those substances are rough and dissimilar, than when smooth or homogeneous. If the sun is the *chief source of motion*, it must, then, be the *source also of friction and of electrical disturbance*. If, too, as demonstrated by Ampère, currents of electricity, passing in circles

* Mrs. Somerville's Physical Geography, page 317.

† The opposite is found also to be the case, especially if we experiment upon such compounds as result from the union between two bodies, both electro-negative or both electro-positive. Thus, the iodide of nitrogen (or azote) is among the most highly explosive bodies, because their union is not in accordance with the powerful affinity resulting from the combination of an electro-negative with an electro-positive body.

around a freely suspended needle, induce the steel to place itself at right angles to those currents, then we have the sun also the ultimate *source of magnetism.*

While endeavoring thus to trace the great law to which this force of terrestrial development is due, it may not be amiss here to ask, although it will be fully discussed in the next chapter, whether this earth-modifying agency does not seem to resemble the same power which swells and bursts the tiny acorn into the majestic oak, capable of enduring the wintry blasts of a thousand years? There seems in it, at least, nothing more wonderful.

To most minds (especially to those aware that the whole Andes are elevated several feet every century, and that new islands of considerable size have gradually risen many feet in a few hours) it must be less astounding to learn that the earth's crust, constiting, perhaps, only the eight-hundredth part of the diameter of our globe, should have separated on its internal semi-fluid and fluid contents, gradually, in the course of long centuries, and finally rested in definite forms, at definite distances, than to reflect upon the fact that a microscopic ovum, perhaps $\frac{1}{240}$ of an inch in diameter, composed of minute granules, surrounded by layers $\frac{1}{2500}$ of an inch in diameter, should expand into a full-grown man, having all that diversity, yet harmonious symmetry, of physical, moral, and intellectual faculties evident in a well-developed human being.

Admit then the possibility of such expansion and separation, and consequently of a force capable of producing such expansion, it may still be asked, What is the *nature* of the forces which have been called into play to effect this separation?

Almost without a doubt, as just mentioned, it was solar influence in some of its modifications; the same power which is daily and hourly elevating the Andes, the whole South American Continent, and some Pacific islands, and as gradually sinking other islands in the Pacific and in the Indian Ocean, or elevating Scandinavia at the expense of its neighbor, Greenland. (See Lyell's Principles, page 166 of the London edition, issued 1850.) Must there not be communication between all parts separated by water, under that water, and if when one part rises another is as gradually depressed, must not that material of communication be plastic in some of its parts? Again; if whenever we see those grand evidences of internal convulsion, evinced by rumblings in the bowels

of the earth and crackings of its crust, we invariably hear of volcanic outbursts of molten materials, not very far from the same vicinity, or of earthquake undulations, propagated according to the laws of fluids, emanating from that region, and nearly simultaneous outbursts of lava at the natural vents of these internal fires, which occasionally are many miles distant, is it not ample evidence that we live on a solid crust, some materials under which are in a fluid condition?

But perhaps those who admit that volcanic agency could effect these results desire to inquire whence this volcanic action arises.

There is, of course, a limit to human knowledge, and if even when the source of volcanic action is found and admitted to be the sun, they still wish to inquire for the cause of that cause, and so on *ad infinitum*, we can only say in reply, that the utmost man can hope to do, is to advance gradually, developing a few more links in the chain of knowledge, aided by the researches of former investigators, who are now enabled to leave us their legacies of mental wealth through the medium of the inestimable art of printing.

To return, then, and pursue our investigations, let us see if analogy with the vegetable and animal germ will not furnish us some clue to the manner in which, and medium through which, this source of volcanic power, the sun, operates.

A seed, which has lain dormant in an Egyptian mummy perhaps thousands of years, may be made to germinate when placed under the combined influence of heat, air, and moisture. In the mummy the seed had the heat, but not the air or moisture. Intercalated between portions of the earth's crust as far as man has penetrated, infiltrated water, and consequently air, have been found.

If this water and air find their way through the numerous cracks, fissures, caverns, etc., in the earth's crust, to the heated materials, (whether metallic bases or even other substances,) there would ensue both chemical union, and consequent disengagement of gases, and also mechanical conversion of some materials into a vaporous or gaseous state, furnishing a powerful expansive force; at the same time, through the means of this chemical and calorific action, friction, vibratory motion of particles, or other causes, electrical currents might be generated, as the materials became cooled; which currents, as the moist crust of the earth is a conductor,

would girdle the globe in less than a few seconds, and give rise to many observed magnetic phenomena.

These suppositions and attempted explanations not only do not conflict, but appear directly to accord, with the opinion advanced by Humboldt, Mrs. Somerville, and others, that the sun (particularly through the violet rays of the spectrum) is one great source of magnetic phenomena, by means of the thermal changes induced. As, however, the satisfactory solution of some of the above-mooted questions requires probably more data, on certain points, than we at present possess, we shall pass on to other portions of the investigation.

If, with a small globe in our hand, having a movable horizon and brazen meridian, we place one apex of a lune (see Definition 3) formed by the junction of two semicircles, (enclosing that fourth of the globe in which Europe and Africa are situated,) so as to correspond with Behring's Straits, and place the opposite apex at the intersection of the Alpine Median Line with the antarctic circle, the lune thus formed embraces, as just stated, Europe and Africa. One of its semicircles divides the waters of the Atlantic about midway, at the same time passing near the Am. Mag. N. P.; also near the point of Max. Mag. Intensity No. 4, while its continuation as a great circle passes near the point of Maximum Mag. Intensity No. 1. The other semicircle of the same lune extends from Behring's Straits to near the Cutch, and along the coast of Madagascar to the antarctic circle, its continuation passing through the Pacific not far from Pitcairn's Island.

Upon examination of Map No. 1, it is readily observed, by tracing the dotted circle, which passes from Intensity No. 1 through Intensity No. 3, the Sib. Mag. N. P., the Am. Mag. N. P., and continues on near Pitcairn's Island, that the points just named are equidistant from the centre of that circle, on the equator, namely, from the region of St. Thomas Island, marked `R′, where the magnetic equator and present terrestrial equator coincide, and where there is little or no magnetic oscillation.

Retaining one-half of the brazen meridian and one-half the artificial horizon in such a position as to indicate the above lune, we have another lune of equal size immediately to its west, enclosing all North and South America; a third similar lune, to the

east of the first, includes most of Asia and Malaysia; while in the remaining fourth of a sphere will be found the mass of the Pacific Ocean.

Again examining Map No. 1, it will be seen that a great circle, from Behring's Straits to the intersection of the antarctic circle with the Alpine Median Line, (a point just indicated above as the probable old south pole,) is represented on the developed cylinder* by the two lines N^{I}, X^{I}, and N^{II}, X^{I}, which, with two other lines form Behring's Straits, dotted through the northern boundary of the map, form two sides of a large square, and of four smaller included squares, each one-fourth the size of the large square, viz., X^{I}, O, M, P, and three others, which can be readily found, although not so readily indicated, for want of a letter on the map to designate the intersection of lines diverging respectively from Behring's Straits and from M, on the coast of Norway, near the Malström.

This point M, it will readily be perceived, is the centre, then, of the great square, and is the angular junction of the four smaller squares, (three of which embrace *nearly* all the dry land on the globe,) and is on the Alpine Median Line. From these facts, and the observations (to be found in Hitchcock's Geology of the Globe, p. 33) showing "that Scandinavia was a centre of dispersion, from which boulders were thrown off eccentrically," there seems every probability that M indicates the central point from which the gradual separation of continents commenced; at which time (if the supposition be correct, that then the greatest amount of volcanic and consequent electric energy was exerted along the plane of force indicated by X^{I}, X^{II}, X^{III}, X^{V}) the magnetic needle, other things being equal, must have pointed about east and west. As, however, the forces, exerted along this plane, repelling each other, gradually receding and separating the land, successively occupied the positions A^{I}, A^{II}, A^{III}, B^{I}, B^{II}, B^{III}, C^{I}, C^{II}, C^{III}, D^{I}, D^{II}, D^{III}, the magnetic forces also changed. When, however, the last convulsions, in the varying planes of the ecliptic, caused the then equator to settle to

* We must bear in mind that, when maps are constructed on Mercator's Projection of the Globe, the eye is supposed situated in the centre of the sphere, and lines drawn from the eye to any part of the globe are continued until they touch a cylinder surface supposed to be wrapped around the globe, with its axis parallel to the present axis of the earth; and that cylinder surface afterwards, cut at any given part, usually Behring's Straits, is rolled out as a parallelogram.

rest at the mean of its oscillations, as our present equator, and the continents reposed according to the laws of equilibrium, the more powerful magnetic force remained nearly at right angles to that ecliptic or last convulsion, indicated by the line on Map 1, from the Magnetic South Pole, continued through R; while the weaker line, to which its longest secular vibrations return these magnetic forces periodically, is indicated by Sib. M. N. P., continued through R.

The above suppositions do not at all conflict, in fact harmonize with the observations of diurnal and horary variations or oscillations, supposed due to the fact that the sun's rays, when exerting their maximum and minimum force* on the earth, temporarily modify these electrical currents, as suggested by Humboldt and others.

This seems the appropriate place to speak of *The Magnetic Axis, the Magnetic Equator, Agonic lines, and Magnetic Intensity.*

1. MAGNETIC AXIS.

An imaginary line passing through the centre of the earth, (having one pole in the region of America, where that end of the needle, usually called the north pole, but having austral magnetism, pointed down vertically, and another in Victoria Land, where the opposite end of the needle, endowed with boreal magnetism, pointed downward to the centre of the earth,) is considered the magnetic axis, and a plane passed through it cutting our equator, about the region of St. Thomas Island, would cut a plane passed through our terrestrial poles or geometrical axis, and through the above named point on the equator, in such a manner as to cross each other at an angle of $23\frac{1}{2}°$, measuring, as in spherical triangles, 90° from the point of decussation. Here, then, we have the two conflicting forces, the terrestrial and the magnetic, (the latter might also be appropriately termed the developing or germinative force,) frequently, as in land separations and in the phenomena characterized as the variation of the compass, contending with each other for the mastery.

2. *The Magnetic Equator*, which coincides with the terrestrial

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* This produces so considerable a diurnal variation of the needle, that my brother-in-law, Mr. R. H. Fauntleroy, informed me that a survey of a moderate amount of land made early in the morning would not agree with one made at noon, unless after due allowance for solar influence.

at the Island of St. Thomas, has its plane nearly at right angles to the above described Magnetic Axis, extending namely from the Am. M. N. P., as laid down by Dr. Lardner, (see Definition 8,) to the M. S. P., as on Map 1., modified, however, locally by various forces. Thus, where the Am. M. N. P. and Terres. N. P. and Sib. Pole exert their attractive force in one line, the land was extended towards the north at Nova Zembla and N. E. Cape, but the Magnetic Equator seems to have assumed its distance of 90°, with some reference to the other two forces just named, and hence is found about 90° from the Terres. N. P.

Tracing it farther east, we find it in the Pacific for a time, about 90° from the Terres. N. P., as well as 90° from the Am. M. N. P. until finally in North America the magnetic and terrestrial poles again come in a line, and the distance is then nearly 90° from the nearer of the two attractive forces, viz., from the Am. M. N. P., gradually rising towards the equator until the two again coincide at St. Thomas' Island, the place of beginning.

The fact of the whole magnetic system altering its position periodically on the globe does not necessarily alter any of these magnetic positions, *relatively to each other*, as pointed out above.

3. AGONIC LINES.

Thus we have, as just mentioned, a *magnetic* axis indicating at its polar extremities the greatest amount of volcanic and electrical disturbance about the period of our latest convulsions or earth separations, while the *geometrical* axis indicates the plane of greatest force at an early period. Some of our great mountain chains, as the Rocky Mountains and part of the Andes, partake of these early directions given, and part of the later, and it is observable that the agonic line, or line of no variation, (namely, where the needle places itself parallel to the geometrical axis, not to the magnetic axis,) is found at points about equidistant from the great back-bone mountain chains.

In the Western Hemisphere, the agonic line seems to pass from the Am. M. N. P. to about Focus No. 2; thence to Focus No. 4; thence near the terrestrial south pole to Focus No. 1; thus pursuing a line about as far east of the great mountain chains in the Western Hemisphere, (viz. 45°,) as it preserves west of the mountains in Australia, when it reaches the Eastern Hemisphere, as well as afterwards

from those of Sumatra, while curving through the Indian Ocean; and again about half-way between the Ural Mountains and those of Siberia, while passing through China to the Focus of Magnetic Intensity No. 3, in Siberia.

Mrs. Somerville, at page 313 of her Physical Geography, remarks that "Imaginary lines on the globe passing through all places where the magnet points to the poles of the earth's rotation, are lines of variation; and lines passing through all places where the magnet deviates by an equal quantity from the geographical meridians, are lines of equal variation; they are also very irregular and form two closed systems of loops; that is, they surround two points, one in Northern Siberia, and another in the Pacific, nearly in the meridian of the Pitcairn Islands, and the Marquesas."

The places thus indicated will be found on a circle dotted in Map No. 1, occupying points equidistant from R, the great axis of oscillation.

The agonic lines may be the connection between median points on the globe, equidistant from two great planes of electrical force, which, neutralizing each other, permit the original north and south attraction along the terrestrial axis to resume its sway; and isoclinal lines seem, as we would expect, to connect points equidistant from the great centre of volcanic and electrical motion.

4. MAGNETIC INTENSITY.

Examining the magnetic power which the earth possesses in varying the oscillations of a needle during a given time, it has been ascertained* that these are greater near the magnetic poles than near the magnetic equator, in about the ratio of three to two, and that there is a near coincidence† between the isodynamic lines, where the magnetic intensities on the earth's surface are equal, and the isothermal lines, where the temperature is equal, and also, as we are now prepared to observe on Map No. 1, between these two sets of lines and those of geological upheaval, such as A^{I}, A^{II}, A^{III}, etc., etc.

* See Lardner's Handbook of Natural Philosophy, (edition of Blanchard and Lee, Philad., 1853,) page 210, et seq.

† The coincidence between the prevailing direction of the stratified mountain masses, and that of the curves of equal magnetic intensity, has been traced by M. de Saussure, and is mentioned by Mrs. Somerville, in her Physical Geography, page 315 of the American edition, issued in 1853.

If we examine Johnston's geological maps of the globe, or Professor Hitchcock's, we see that, in order to bring the hypogene rocks of America and those of northern Europe to form a regular curve; or in order to make the palœozoic and mesozoic rocks correspond, and finally the tertiary, in each continent, we must not only bring the two continents in actual contact, but we must slide a portion of North America into western Europe, the northern mass of South America on to the great Sandy Desert of Sahara, when sunk, as already remarked, beneath the waters of the ocean, Eastern Asia on to the great Sandy Deserts of Tartary, and Australia on to the submerged Sandy Desert of Arabia.

We have then, somewhat as represented in Diagram 1, (by restoring the curvature that South America lost when attracted by the south pole, during its removal on plastic materials, and restoring the curvature of the mountains in Hindostan,) a regularly curved union of the highest and most prominent mountain ranges on the globe, viz., the Sierra Nevada range, the Andes, mountains of Central Africa, those of Australia, of India, and of Eastern Asia; while inside of this we have a lesser curve of mountains converging from the Rocky Mountains, namely, the Sierra Madre, Atlas, Taurus, Hindoo Koosh, Thian Shan, and Altai Mountains—the ribs, as it were, of the outer back-bone range; with yet another curve, converging from the Rocky Mountains, the Pyrenees restored to their position, the Alps, possibly the Carpathian straightened out, and, finally, the Ural Mountains; while a yet smaller curve trends from the Rocky Mountains, along the somewhat displaced Ozarks to the Alleghany range, connecting with the Scandinavian Mountains.

These mountain curves very generally, as above stated, although not always, follow the direction of the planes along which volcanic and electric force have been exerted.

The chief exceptions mentioned are found in the Andes and Pyrenees, both of which ranges we suppose not to occupy their original strike.

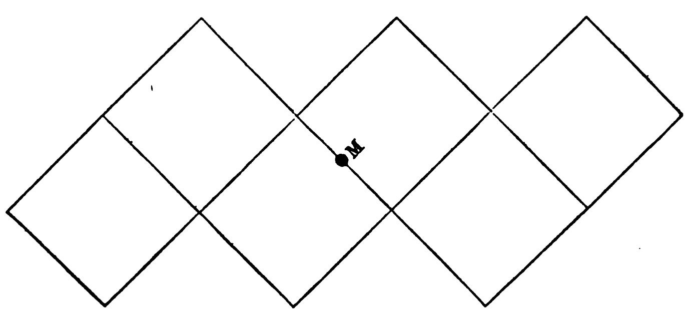
The greatest magnetic intensity will *perhaps* be found farthest from centres of magnetic oscillation, at which places continents were separated from each other, as at Intensity No. 1, between the ruptured Antarctic and Australian continents, where the electrical forces had acquired their utmost energy; or as at Intensity No. 4,

between South America and Africa. Numerous curves can be drawn by finding the correct centre, and made to pass through several points of maximum intensity, as the curve on Map No. 1, marked by alternate lines and dots, from Behring's Straits through Intensities Nos. 3 and 4.

It will also be observed that the dotted lines from the Am. M. N. P. to R, and from the Sib. M. N. P. to R, form the long diameters to two equal figures, resulting* from arcs which, intersecting, form again several spherical triangles, the central one of which encircles Africa and part of Europe, up to the point of separation, M; and the two dotted lines above mentioned as connecting R respectively with the two north poles, indicate also the direction along which any mass of matter would be moved by forces acting from that central point outwards, provided no counteracting force operated, in which case the movement would be intermediate.

The early separations in the north seem to have partaken of the fissiparous vertical, as might be expected from the hard crystalline, igneous, vertically upheaved character of the rocks; whereas the later separations, resulting from the intercalation of water, lava, etc., between the separately and horizontally deposited layers, gave rise to such removal as we find when portions of the South American Continent were gradually forced in the direction from R along D^{III}, in the manner mentioned above, from off the Great Sahara of then submerged Africa; just as Australia, connecting that continent with the Asiatic, was, by the same law, sent in a direction, following the line R along D^{VI}, from the region of submerged Arabia, to its present resting-place.

In the developed *cube-cover* or *cell-wall*, as below, (see Dupin's



* See Hutton's Mathematics, edition of 1818, vol. iii., page 82, Sph. Trig., Theorem iv., and Scholium.

Collection of Polyhedral or Stereometrical Figures, published by Molteni & Siegler, Paris, 1847,) we find the point M equidistant from any two corresponding points on the exterior of this surface-figure, rendering it a probable point of rupture: a probability confirmed, when we learn, as already stated, that the centrally scattered boulders diminish in size and number as we recede from this scene of forcible dispersion.

Attention might be called to numerous facts bearing on this subject, but it is thought best simply to enumerate in the Appendix such other miscellaneous data and extracts from works as it is supposed might prove useful in drawing general conclusions regarding the dynamics of Geology. Only one additional subject, in this connection, seems here to require mention; that is, the *direction* and extent of the force producing earthwaves, earthquakes, igneous outbursts, etc. Many valuable data relating to these points may be collected from the minute observations of Lieut. J. M. Gilliss, in command of the United States Naval Astronomical Expedition to the Southern Hemisphere. Particularly at pages 97, 98, 100, 101, 102, 104, 105, 106, 107, 110, 114, 116, 117, will be found details regarding the direction. There seems evidence that the earthwave more usually arrives, in that region, from the west, or occasionally the north-west, and passes off in an easterly direction; sometimes, however, in a reverse or reflex course, namely, from east to west; somewhat in the same curve as D^{IV}, on Map 1.

Further observations, at different points, may establish as a fact that which at least seems probable, that electrical force, the supposed immediate cause of volcanic upheavals, is transmitted chiefly along metallic vein-masses from the region of the Pacific, either east or west, back to the same region again, (in a manner similar to the passage of nervous force,) accompanied generally (see Gilliss, pages 85, 94, 96, 97, 99, 102, 108, 112, 114) by auroras,—austral in these cases, boreal in others,—by lightning, heavy rains at unusual seasons, and sometimes by the drying up of springs, after earthquakes,* as in that of 1835, (see page 301 of the above work.)

* An intelligent gentleman living near the Blue Lick Springs, Kentucky, informed me that one of the best springs on the left or south bank of the Licking River dried up immediately after the earthquake at New Madrid. The direction from the spring to New Madrid is on a line parallel with the Ohio, and parallel with our lines of upheaval, on Maps 1 and 2, B^{I}, B^{II}, and C^{I}, C^{II}.

A large amount of valuable information on these subjects may be collected from other portions of the same interesting and valuable Congressional document.

We now leave the further consideration of the dynamics connected with the formation and modification of the earth, although aware that the subject has been very imperfectly treated, hoping it may perhaps furnish some hints to those engaged in similar investigations on this interesting topic, and we pass on to one not less so, the endeavor to trace out the type or general plan, which served as a basis for inorganic structures, as well as for those in the two other kingdoms of nature.

CHAPTER III.

Anatomical and Physiological or Stratigraphical Geology: an attempt to demonstrate the analogy existing between organic structures and geological strata.

WERE the sole object to present this portion of our investigation in the manner least likely to repel by its apparently chimerical speculations, policy might dictate to begin with one of the most prominent points of analogy, and endeavor to establish that first, gradually proceeding to those similarities least apparent.

But, under the firm conviction that truth will prevail, and not desiring that statements should, even for a moment, be admitted, unless founded on imperishable truth, it seems more philosophical to present, at one synoptical glance, the most remarkable structures in which the type of formation is considered as indicating *one and the same plan.*

After presenting the general view, we can then follow out, in detail, some of the important points of resemblance, leaving, as usual, much for the reader to supply, and for the man of science, devoted to this particular branch, to improve upon and to perfect.*

Beginning first with an examination of that which we have assumed as the type of creation, we perceive in *inorganic* matter how much more readily crystallization takes place, when there is a nucleus or regular solid, be it ever so small, upon which the surrounding water can deposit the similar material it holds in solution; forming, outside of each regular, small solid or aggregation of solids, an investing film by evaporation of the solvent fluid. Even when the spicular material is different, it still aids: thus, we see

* See Tabular View.

TABULAR COMPARISON BETWEEN STRUCTURES.

TYPE.	ORGANIC. ANIMAL KINGDOM.			VEGETABLE KINGDOM.			INORGANIC. MINERAL KINGDOM.		
Nucleus.	Germ-yolk......	*Early serous* layer; forming Endoskeleton, etc., (except apophyses,)...........	Nervous system.	Nucleus	Ovule developed into the seed.	Embryo.	Primitive crystal or nucleus.	Homogeneous minerals, giving rise to heterogeneous *Rocks*.	*Early Hypogene* Rocks. — Ancient Volcanic. / Plutonic. / Metamorphic.
			Osseous " including ligaments, tendons, muscles, some membranes, etc.						
									Secondary Hypogene intervening.
		Vascular layer.........	Respiratory system.	and					*Secondary* Sedimentary Rocks......... — Palæozoic. / Mesozoic.
			Circulatory "	Pulpy mass.					
									Tertiary Hypogene.
Formative or nutritive fluid.	Albuminous food-yolk....	*Mucous* layer...........	Nutritive "	(Amnios.)		Albumen.	Water of segregation and deposition, or crystallization.		*Tertiary* Sedimentary Rocks...... — Eocene. / Miocene. / Pliocene.
			Reproductive "	Secundine		Integuments.			
				and					Quaternary Hypogene.
Epithelial investment or cell-wall.		*Late serous* layer: exoskeleton, integuments, hair, teeth, and limbs, (apophyses of Endoskeleton,).................	Dermal "	Primine.			Secondary crystal or solid investing deposit, (crust.)		*Quaternary* or Post-pliocene, including Drift or Glacial Period....... — Diluvium. / Alluvium. / Ice. / Water.
			Dental "						
			Locomotive "						
Connection with matrix.	The internetting of fetal vascular tufts with maternal blood-sinuses, giving off deciduous layers, forms the.......................................		Placenta, with its umbilicus.	Developed at each of the two edges of the carpellary leaf are the......		Placentæ with their funiculi.			Atmosphere and luminiferous ether — The medium of vibratory undulations between solar and planetary spheres.

silex deposited, as flint, around sponges, and other nucleiform materials during the chalk period. The same principle holds good in organic crystallization: thus, the formation of regular crystals of sugar is much promoted by suspending in the saturated solution a crystal already solidified. The *vegetable* ovule, in its early stage, consists of a central pulpy mass, the nucleus, an interior secundine, (which may be the formative material consolidated, as we do not, at all stages of development, find that which is termed the typical formative fluid a liquid,) and an outer integument, the primine, typifying the cell-wall. Turning our attention now to the *granule* or *molecule*, the simplest and most minute of *animal* structures, we find it generally believed that it consists of particles of matter, perhaps fat, coated with albumen, deposited on them from the fluid in which they float.* Examining the next simplest elementary structures of the animal, we find *cytoblasts* made up of internal nucleoli (the nucleus in the above assumed type) surrounded by a colorless pellucid fluid (the formative fluid in the type) enclosed within cellules or walls of simple membrane† (the cell-wall in the type.)

The *primary cells*,‡ also, (although the *nucleus* seems wanting occasionally, especially in the progress of degeneration,) are usually composed of membranous cell-walls, enclosing liquid contents, around a nucleus.

The human ovule or *ovum*,§ measuring from $\frac{1}{240}$ to $\frac{1}{120}$ of an inch, has an external investing membrane about $\frac{1}{2500}$ of an inch in thickness, which encloses the yolk, or vitellus, (composed of granules imbedded in a fluid,) the yolk in its turn surrounding the germinal vesicle. This *germinal vesicle*‖ itself consists of a fine transparent membrane, containing a clear watery fluid, which surrounds the germinal spot. That germinal spot, under certain circumstances, develops into the full-grown individual, and must, therefore, contain within itself some of the nucleiform elements of the whole stock derived from that individual.

Returning to the ovum, we again find our ternary type, when the ovum floats in the granular zone or discus proligerous, and in the fluid of the Graafian vesicle, enveloped in its epithelial tunic, the

* Kirke and Paget's Physiology, (edition of Blanchard and Lee, Philad., 1853,) page 30.

† Ibid, pp. 30, 31. ‡ Ibid, p. 33. § Ibid, p. 471. ‖ Ibid, p. 472.

membrana granulosa; this at maturity bursts and discharges the ovum.

In passing through the Fallopian tube, a transparent layer of albuminous substance is deposited on the zona pellucida, and forms the chorion, while the yolk meantime performs regular and energetic rotary movements, produced by the action of vibratile cilia, upon its surface.

This is typified in the inorganic world by the deposition from water of new surface-materials, the interior contents of the earth being roused into volcanic action by the vibratory stimulus communicated from the sun through the medium of the atmosphere.

After the dot of the ovum has developed into an embryo, we again meet the type when the contents of the yolk-sack envelop and nourish the germ.

Examining the full grown individual, (the vegetable, and some of the lowest animals,) we find, for example, in the sponge, a spicule, surrounded by a simple fluid, and an investing tissue; that spicule or rudiment of the endoskeleton and nervous system, enlarges in some mollusks into an internal bone, (such as that of the cuttlefish;) in the cartilaginous fishes into a gelatinous envelope; in the higher classes of vertebrates into a denser body, giving off arches and apophyses: the neural arch for the protection of the nervous system, with its centralization in the encephalon; the hæmal arch for the protection of organs contributing to vegetative life, namely, the respiratory and vascular systems, having their centralization in the thoracic cavity; as well as the nutritive and reproductive, occupying the largest cavity, the abdominal; while the vertebral apophyses form the terminal organs of locomotion.

I am free to confess I should scarcely have had moral courage sufficient to put forth some of the above doctrines, had we not the sanction and authority of such a man as Professor Richard Owen, of London, showing that the vertebral bone was the type of the whole skeleton; and that even the skull, with its complicated apparatus, was but the modification of several vertebræ.

Even with such an example before me, knowing that I entered the scientific arena at a comparatively recent date, and feeling, as I before stated, my deficiency in many branches bearing on the subject, I advance these suggestions, rather hoping to elicit discussion and information, than professing to establish assertions.

Of the botanist I would ask, whether, in the developed plant, I am justified in following up the analogy thus?

In the vegetable world, the nutritive system, instead of occupying a large interior cavity, is developed by its descending axis, the roots, into the earth, whence it draws, in the form of water, dissolving various inorganic ingredients, its materials for growth; the spongioles are the mouths, the fibrils and caudex the types of the early alimentary canals and cavities.

An aggregation of cells, as in the animals, forms cellular and vascular fibres, interlaced into tissues, which, in the dicotyledonous or highest organizations, constitute spiral, vascular tubes and intercellular spaces for the elaboration and upward circulation of the imbibed nutritive materials. In the cellular tissue of the leaf we have typified the parenchymatous structure of the lungs, where the circulating fluid or crude sap is converted by the action of chlorophyle, the absorption of oxygen, and exhalation of carbonic acid, into the proper juice, or latex,* which, during its descent through the alburnum or sapwood, deposits the nutritious ingredients, such as we sometimes draw off in the form of sugar-water, gums, resins, etc. The retention of some of these solid materials in the vascular tissue consolidates them, when the watery portions have passed off, into the lignin or woody fibre of the heart-wood, particularly during the abstraction of heat in winter: and thus, counting the enclosed pith, with its medullary sheath, and the inner layer or concentric zone of woody fibre for the first year, and one additional year for each layer, we determine the age of the tree; just as the farmer counts on an ox the point of a horn (with its contained medulla or marrow, its periosteum and bony material consolidating from the cartilaginous to the calcific stage) for the first three years of life, adds one year for every ring or layer of deposited albuminous matter, and thus determines the age of his animal.†

Turning from the especial examination of the vegetable to that of the animal world, we next observe that, even in man, the type alluded to above is preserved: around the nucleus which, in the form of spiculæ, etc., and finally of vertebræ, constitutes the endoskeleton, the formative fluid, blood, deposits its materials of nutrition, as fibrin, etc., that (like the lignin of the dicotyledonous

* Wood's Botany, p. 98.

† Strictly speaking, this is rather the analogue of endogenous vegetable growth.

plant when forming wood) consolidate into the nervous, osseous, and muscular system; while the same fluid deposits, at a later period, externally, from within outward, the less important exoskeleton, (typified in a lower vegetable grade, the endogenous phanerogamia,) in the form of a locomotive and dermal system.

But the comparison is incomplete, until we bring the third great kingdom of nature into the arrangement; and this I now find has already been alluded to by Raspail and Schwan,* although I was not aware of it when I commenced this chapter.

Emboldened by such authority, I proceed to ask the geologist and physiologist, whether there is not an analogy between the formation of the earth and of its inhabitant.

Our planet, perhaps, typifies an ovule from the solar matrix: in its earlier igneous, chaotic state, it bore analogy to the yet undeveloped amorphous structure of vegetable ovules and the animal ovum. Like them it had at an early period a nucleus, on which, after a time, air and moisture deposited additional materials, derived from the matrix. At a yet later period, a part of these same materials were carried in mechanical mixture, partly in chemical solution, to promote the development of later formations, forming new continents, etc.; just as a portion of the seed (the albumen) and the food-yolk of the egg go to nourish the expanding germ.

The separation of continents typifies the propagation by offshoots, or artificially by cuttings, in plants; and seems to resemble the fissiparous mode of reproduction observed among the lowest animals. In some of the earlier cataclysms, we have the type of the ruptured Graafian vesicles, while at a final convulsive deluge, the period when the Western Continent and Australia were detached, and when possibly the moon, as a terrestrial ovule, was thrown into space, we readily recognize the type of ruptured pericarpal dissemination of seed, in the vegetable world, of completed incubation and parturition in the animal kingdom.

But the analogy may be carried much farther: the earth, like man, has its mountain masses giving stability to the length and sometimes the breadth of the land, just as the skeleton forms the framework of attachment for muscles, etc. The materials solidified at the earliest periods are crystalline, depositing materials around

* See Horner's Anatomy and Histology, p. 66.

central points,* as the earliest bones, those of the head,† commence their ossification by the arrangement of cells around a centre, or as the earliest animals partake of the radial type. At a later period the same materials (the serous layer of the germ-yolk, in the animal; the detritus of igneous materials, in the mineral world) furnish an ample deposit, which, in the long bones of the limbs, (femur and humerus,) in the muscles, etc., now partake of a lamellar appearance, (see Diagram IV., figs. 19 and 21,) the result of cells arranged in layers, viewed in their vertical sections. On the earth's crust these deposits are carried by aqueous action from the high and hard mountains, and are afterwards consolidated, by heat, pressure, and electrical forces, into the sedimentary rocks of the various later periods.

When an abundant supply of carbon has been furnished for the growth and subsequent decay of vegetation on the earth's surface, we then have the type of an extra-uterine nourishment.

We have the coal period forming its vast layers of carbonaceous deposits, which, by slow chemical action under a portion of the earth's crust, the evolution of various gases, and the formation of new compounds, aid in keeping up the temperature of the internal earth. The water, trickling through the earth's pores, dissolving and carrying many saline and other ingredients to the ocean, is the type of the early lacteal products in the animal mingling with the venous blood, to be carried to the great centre of circulation, the

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* Any one observing, closely, soil somewhat aluminous gradually drying and cracking, particularly when the crust has been trodden rather compactly, will perceive that it separates, if deeply fissured, in such a manner as to leave polygonal columns at right angles to the surface of the earth, similar to basaltic columns, (see Diagram IV., figs. 10 and 11,) usually pentagonal or hexagonal, resulting from ancient volcanic materials cooled probably under water. As the shrinkage produces a separation in many directions, this is a result we might readily expect.

It will also be perceived, if we empty the yolks of a number of broken eggs into a deep vessel, so that they press against each other, that they no longer retain a spherical, but assume a hexagonal form. This takes up the least room, hence the reason why the instinct of bees leads them to construct their cells on this plan: hence, too, the economy of space and the strength evinced in the various forms acquired by the calcareous framework of the coral animal, as it is secreted in a plastic state. (See Diagram III., figs. 8, etc., on the right; the germination of seed, on the left of the diagram, having been erroneously marked fig. 8 also.)

† See Diagram IV., fig. 20.

heart, as the small streams unite into large, and carry the dissolved materials to the great deltas, and finally into the ocean gulfs.

Turning our attention first to the Western Continent, we find, as just stated, the smaller streams anastomosing, (as the veins do to form the vena cava,) and at last discharging the chief waters of North America, by the Mississippi, into the Gulf of Mexico; while the Orinoco, Amazon, and Rio de la Plata send the inosculated waters of South America also toward the same gulf, through the currents tending to the Caribbean Sea.

Here we have the type of that venous or vitiated blood, which is now thrown into the great central heart, and thence propelled, in the Gulf-Stream, chiefly north and east, toward those regions where the ocean is less salt, as the Baltic; entering also the Mediterranean, and leaving there large saline deposits, the water of the ocean is evaporated by the heat of the sun, increased in intensity by reflection from Africa's sandy Sahara; and, thus purified, the aqueous vapor mingles with the atmosphere, to be carried along by its currents, until the accumulated humid contents of a cloud (typifying arterial circulation) descend, when its temperature has been depressed to the dew-point, as a pure deposition of aërated water, upon the thirsty earth, and filter through the loose soil, to carry nourishment to that earth, its plants and animals, and again perform the same circulating course of evaporation, purification, and condensation.

The atmosphere, then, besides forming the type of aërial com munication between parent and offspring, as indicated in the tabular view, is the type too of the great aërating organ, the lung, (whether under the form of external branchial tufts or internal parenchymatous structure, forming pulmonic sacs.)

If the above be true, I would ask the scientific man not to sneer, when I hesitatingly inquire, whether it is possible that in the Western Continent we have the male type, of greater length with less breadth, even the type of the air-breathing animal, with its vast central air-caverns; and whether, at a former period, it foreshadowed the usual fœtal curvature *in utero*, before extension; whether in the Eastern Continent we have the maternal type, the cretaceous period corresponding to that of lactation, the greatest pelvic width typified in the highest Himalayas, and the water-breathing type with its central intercommunicating whirlpools?

Well aware of the ridicule to which I expose myself, and feeling keenly the criticism of those competent to decide, I yet am impelled by a sense of duty to ask these questions, not as mere matters of speculative interest, but as queries, the answers to which may lead to important practical hygienic results, such as it will be attempted more especially to develop in some of the remaining chapters.

Should the *probability* of any of the above analogies be admitted, Australia at once establishes its claim to the placental type, as well on account of its former position, approximately indicated in Diagram I., and the great evidences that the upper layers have been torn away, leaving an arid country around the Dead Sea some thirteen hundred feet below the level of the Mediterranean; as also by the marked peculiarities of its flora, (for instance, its leafless acacias, the petioles of which retain the nourishment that they should transmit to the leaves,*) and of its noted fauna, among which so many belong to the order Marsupialia,† exhibiting a tendency to an extra-uterine pouch or enormous development of the nipple integument, while other animals of that anomalous continent, and its detached New Zealand, form the link between the oviparous bird and viviparous mammalia, the monotremata.

In the attraction exerted by the moon over the tides, we have the type of the periodicity, to be enlarged upon more in the Chapter on Pathological variations; and it may suffice now to ask again, whether we have not, in the periodical flux and reflux, the type of normal and abnormal, regularly recurring exacerbations, as in intermittent and remittent fevers, in the periodical excretions, alvine, urinary, etc., in the catamenia, and even in the arrival and departure of epidemic agency?

To recapitulate, in a more connected form, this comparison of inorganic with organic phenomena, we observe that the older rocks (the hypogene, crystalline, non-fossiliferous) are chiefly found in the arctic and antarctic regions, (although, also, more or less accompanying every period;) next to those come the Secondary, (Palœozoic and Mesozoic rocks,) chiefly in the north temperate zone; while nearer the tropics are chiefly developed the Tertiary

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* See Mrs. Marcet's Conv. on Botany, London Edit. of 1829, vol. i., p. 85.

† See Diagram V., giving the classification of animals.

and newer formations. The Hypogene rocks, being of all ages and forming the hardest and highest mountain ranges, as well as in other particulars, to be pointed out below, resemble the serous layer, which forms the great framework and consolidates at different periods of life. The Secondary formation resembles the vascular layer; and the Tertiary is the analogue of the mucous layer, although in the animal it is more frequently an internal than an external layer.

To enter somewhat more into detail: As already stated, the serous layer, in the animal, gives rise to the nervous, osseous, and muscular system; the Hypogene layer, in geology, gives rise to the Plutonic period, to the mountain ranges, which constitute the strength of the earth's crust, and more especially gives rise to the great backbone system of the globe, extending from the head of the North American ranges (Sierra Nevada, Rocky Mountains, etc.) along the Andes, and through eastern Asia back to the place of beginning. The Hypogene period also gives rise to the ancient and modern volcanic rocks, still moulding and altering the earth's crust, under the influence of this active agent, producing electrical disturbance, as detailed in Chapter II., thereby causing magnetic phenomena. This is the type of the nervous system, while the layers of muscular tissue, separated by their fascia, are typified by the metamorphic rocks, composed of their various schists or slates; and it is in these that we find the occasional veins of many of the useful metals, obtained *more abundantly* from the ancient volcanic rocks of the Secondary period: the *gangue* being, perhaps, the analogue of vascular walls, and of neurilemma.

Thus the greatest amount of mineral wealth is met with, as just stated, when we reach the Secondary period, where the accompanying volcanic rocks, as trap, (basalt, greenstone, etc.,) chiefly in dikes, bring these metallic riches to the surface, amid the yet more valuable carbonaceous and saline deposits: just as we find a large number of veins, arteries, and nerves among the organs of circulation and respiration, (the vascular system,) and a large amount of carbon, salts, some iron, etc., in the blood.

Emanating from the backbone or main mountain range of the earth, we find originating about this period the Tertiary layer, which receives many of these Secondary products, and dissolves them in its waters and oils, giving rise to bituminous and saline lakes and seas, amber, petroleum springs, etc,; it imparts also,

even to its vegetable growth at the present day, sap-products, analogous to those bitumens, such as the caoutchouc, the gutta percha, the camphors, and the resinous and balsamic vegetation of the tropics.

As attention will more especially be called to this part of the subject in the next chapter, suffice it here to mention a few prominent facts.

In the detritus or soil resulting from the disintegration of the primary *Hypogene* rocks, we find chiefly the cryptogamic algæ, lichens, mosses, and similar plants, largely abounding in gelatinous starch, (mucilaginous fecula,) and some of the animals, fossil as well as recent, supposed *formerly*, known to abound *now*, in chondrin, a modification of gelatin,—as the cartilaginous fishes,—while the animal matter of the mammalian bones is true gelatin.

In the *Secondary* period, we find the starch gradually converted into sugar. In the cereals grown on the present soil of that period, starch yet furnishes an abundant supply of food for man;* but already many of the dicotyledonous trees contain sugar in their sap, (as the maple, hickory, poplar, etc.;) so do many of the berries common in the Palæozoic period; while the Mesozoic is rich in the sugar of its canes, beet-roots, etc., indicating at first chiefly grape-sugar, (glucose, C_{12} H_{11} O_{11},) but at a somewhat later period, when more oxygenated, chiefly cane-sugar, (C_{12} H_{14} O_{14},) possessing a higher sweetening power.

In the *Tertiary* period, oxygenation has rendered even some of the rivers acid, as the Rio Vinagre, in South America, and a lake in Java; vegetation begins to develop the fruits replete with acid, (pine-apples, oranges, lemons, tamarinds,) and other products of a more advanced oxygenation or fermentation,—well adapted to cool the fevers engendered by the heat of intertropical regions,—and in the animal economy the *later* process of stomach-digestion, as well as of intestinal-digestion, is *acid;* whereas the *earlier* process in both is *alkaline.*†

In this geological formation, or else in the early part of the Post-pliocene, we find, too, the numerous cathartics, (muco-incremental

* Before, however, starch can be assimilated, it has to be converted into grape-sugar, by the action of the saliva. (Draper's Phys., p. 46.)

† Consult Draper's Physiology, pp. 63 and 64.

agents, jalap, rhubarb, aloes, etc.,) and the muco-decremental agents, such as opium, etc., designed to furnish remedial agents for the diseases—chiefly of the abdominal viscera or mucous canal—incident to those regions.

Still farther south, we again come to the analogues of the *later* products of the serous and of the mucous layers. Thus we have in the mineral world the diluvial and alluvial washings deposited over vast surfaces of country, covering the older rocks and affording soil for vegetation; in the vegetable kingdom we find, in those southern regions, enormous developments of the leaf and its appendages, evinced in the extension of their divergent medullary sheath and cellular tissue into such dermal growth as is observed in the water-holding pitcher-leaves of the Nepenthes and of the Dischidia, in the East Indies, of the Tillandsia in South America, of the Sarracenia and teazel (Dipsacus) in North America, etc.* In the animals of tropical countries are also found, as will be more enlarged on hereafter, the wrinkle-skinned and long-tusked elephant, the long-armed ape, the long-necked giraffe, the long-maned lion, the extended pouch of the pelican, the compound stomach of the ruminantia, and the extra-uterine sack of the marsupials, etc., etc.

Glancing now at the chemical elements, and reducing them to our type-standard, we cannot doubt that carbon is the analogue of the nucleus; oxygen and hydrogen (water) that of the formative fluid; while in oxygen and nitrogen (the atmosphere) will be observed that of the investing material, usually a thin investing solid, but always,—whether the albuminous investment of a granule, the outer membrane of the egg, the investing skin of the adult animal, or the absorbed amnios converted into the cotyledon integument,—like the atmosphere, nitrogenous in character. These cell-walls, also, like the atmosphere, derive one portion of their investing material from the formative fluid.

In the early formation of the globe, as in the early life of the animal,† nutrition or deposition of material, from the maternal or other source, predominates over the waste; in middle life there is an equilibrium of increase and decrease; while in late life, under the form of manifold animal excretions, of cast-off vegetable bark,

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* Wood's Botany, pp. 93, 94, 97.

† Agassiz and Gould's Prin. of Zool., p. 72

and of water-washed mineral detritus, the waste, oxidized worn-out materials are thrown off at the expense of the layers first formed.

In old age the bones yield up their gelatin, the muscles especially part with their nitrogenized fibres, the areolar tissue too gives forth its adipose matter, and the relaxed skin shrivels into wrinkles.

Judging from this analogy, our earth is yet in her prime: portions of her northern granites, hypogene slates, etc., are annually carried by rivers to form vast equatorial deposits; yet the upheaving of the Andes, the coral-forming islands, and other evidences, point to a formation of new material sufficient to counterbalance the waste, unless indeed a submerged Pacific continent sunk to rise no more, as the antipodal land gradually brought its recent deposits dripping from the bed of the ocean, which then might be considered indicative of completed maturity.

If the above analogies are correct, the northern regions transmit their volcanic energies past the decussating point at Behring's Straits, and send volcanic force from the Pacific, in which we find so many volcanic outbursts, in circles around the globe, but chiefly in a great circle, found on the globe when we elevate the north pole about 23½° and bring Behring's Straits under the brazen meridian, while we place Chimborazo at the horizon. We then have, in the great circle under that horizon, a belt of volcanoes, pointed out by physical geographers,* giving evidence of constant action, and having in their vicinity much metallic wealth, enclosed in the gangues of igneous upheaval. The metallic veins in these gangues may, as good conductors, facilitate the transmission of the electrical agency which promotes volcanic action, and as such would typify the spinal nerves, while others are the analogues, perhaps, of the ganglionic or even of the cranial nerves: carrying the nervous force to the extremities, and there producing earth-movements and convulsions, in the same manner as the nervous force stimulates the muscular fibre to alternate expansion and contraction, when the brain *wills* it, or as involuntary muscular action (such as that of the heart and lungs) takes place, regardless of our attention.

Having thus pointed out a few of what seem proofs of the same general plan of creation having been adopted in the mineral world

* Prof. Guyot, I think, makes this remark in his admirable work, entitled "Earth and Man;" but I am at present unable to find the page of reference.

which we have so often admired in the organic, modified doubtless for the less complex functions to be performed; and admitting that all structures arise, as has often been demonstrated, from the cell, that *that* cell consists of an investing cell-wall, a contained formative fluid and a central nucleus, for alternate deposition and re-absorption, we next proceed to examine the type or general plan upon which cells are arranged, to form the vast diversity of structure visible in the three kingdoms of nature.

The radial type seems to pervade the whole of the solid structures: the arrangement of concentric, gradually-enlarging cells, in such a manner around a nucleiform single cell that, examined in a horizontal section, we see these concentric cells form also lines of diverging cells. At the same time, there seems usually to be a dissepimental medullary communication between the nucleus and the outer cells: ultimately forming, in the mineral, the planes of primary clearage, or, in the stalactite, the concentric layers of deposition; in the plant, the carpellary subdivisions of the ovary, or, in the dicotyledonous tree, the medullary rays of exogenous growth; and in the animal, the dissepiments diverging from the original point of solidification to the last.

To apply the above again more in detail to the three kingdoms, we observe in the earth's nucleus one uniting line, whose dissepimental edges are to be found on Map 1., extending from northern Arabia to the central point M., near the former of which, when Australia occupied its original position, were developed, *perhaps*, the earth's spore, probably all vegetable growth, and certainly animal life: exactly the analogue of the position in which, in the vegetable world, we observe the placentæ—formed at the two edges of the carpellary leaf—developing the ovules. So, too, beginning with the radiates, we cannot fail to observe (under almost every form in which the different genera of marine polyps have deposited their secretions, afterward consolidated into the framework or skeleton of the animal) a constant tendency for dissepiments to diverge from a central point; others form concentric partitions in the same vertical planes, while a third set of dissepiments constitute horizontal partitions: the whole being, in short, merely the junction in continuous lines of the cell-wall of each individual, compressed most frequently into the form calculated to take up least space while giving most strength, the hexagonal, more or less perfect in its

planes. This is observable again in the transverse section of a crinoid, of the various forms of stelleridæ, (where occasionally the arms of the starfish are entirely and widely separated between those dissepiments,) and also in the partially-absorbed partition-walls of the echini, with their central nucleiform "lantern of Aristotle," radiating towards the ambulacra, which enclose between them the pentagonal cells consolidated into calcareous sphere-plates, the latter bearing upon their tubercles the spiny organs of locomotion.

The same plan of consolidation may be minutely pointed out for the next higher departments; but it will probably be sufficient if we follow out the details among the mollusks, before closing with its application to the higher vertebrates.

In the vesicle of the spawn and in the ova of the mollusks, we find the young animal forming a mere minute point of consolidation, the future apex of the bivalve beak, or the univale spire. The young animal secretes a viscid fluid, the analogue of our blood, and deposits that slimy aggregation of granules from which, as the fluid evaporates, the shell is increased in size. Thus the common snail may be seen to repair its damaged framework, just as our blood throws out its lymph granulations, which afterwards, aggregating and consolidating, close the abraded skin by an albuminous cicatrix. As the animal increases in size it acquires greater energy, and secretes larger cells, deposited in the concentric layers of growth or increbescens, represented in Diagram III., fig. 7; while the radiating lines, so prominent in some of the brachiopods, as leptena alternata, spirifer lynx, or in the recent pecten costatus, are the dissepimental layers, occasionally giving rise to small or large spines, as in the fossil productus semireticulatus, or in the fossil and recent spondylus. The cause of the disproportionately enormous development of one valve over the other, observable, for instance, in the calceola sandalina, or in the gryphæa incurva—and yet more in the hippurites and sphærulites—will be discussed hereafter.

We next examine the ossification of man's skeleton, and we find that the vertebral bone, the type of the whole, commences its ossification somewhat in the following manner:

The blood is the formative fluid; it contains within it, according to the type above described, a nucleus, the blood corpuscle, which

itself contains again a nucleus, a fluid, and an investing membrane. This nucleus becomes absorbed, the investing membrane thins down and develops new cells from the outer wall of preëxisting cells;* "cells coalesce with adjoining cells similarly circumstanced, and with the intercellular substance, the cytoblastema: the cavities of the cells all the time remaining separate." Around the centre of the body of the vertebral bone, as well as around the punctum ossificationis in the bones of the head, and around the *epiphyses* of the longer bones, we find the gradual arrangement of cells (perhaps the corpuscles of Perkinje, perhaps Haversian ossicles) separated by the Haversian or medullary canals: the whole passing through the stages of the early mucous and cartilaginous to the calcific; some, as the sternum, only acquiring osseous hardness in advanced life.

The vertebral bone, in its full and typical† development, "forms a bony hoop or arch, above a central piece, for the protection of a segment of the nervous axis, and a bony hoop, or arch, beneath the central piece, for the protection of a segment of the vascular system."

The upper arch is called neural, from *neuron*, nerve; the lower, hæmal, from *haima*, blood.

The upper and lower extremities (such as, in man, the arms and lower limbs) are considered apophyses from the vertebra; and we still discern the radial structure even in the arrangement of the carpal and metacarpal bones with their phalanges, and in the tarsal and metatarsal divergence.

Viewed in vertical section, as already alluded to on page 85, the long bones exhibit a lamellar structure, due to the elongated planes of the dissepimental cell-walls. A transverse section of fully-formed bone usually shows the greatest consolidation of the deposited materials towards the external circumference, leaving a central cavity, after absorption of the nucleiform materials,‡ combining thus lightness with strength.

This arrangement of materials in a radiating form, leaving either a globular or a tubular cavity, is found in the mineral world among the geodes, nodules, etc., and among the fulgurites; in the vegeta-

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* Horner's Anatomy, vol. i., p. 71.

† Prof. R. Owen on the Principal Forms of the Skeleton, Blanchard & Lea's Edit., 1854, p. 26.

‡ Draper's Phys., p. 245.

ble world we observe it in the hollow canes, etc., of endogenous growth, and in the dicotyledonous tree of extreme age.

The formation of other tissues, in the animal, is so similar to that of the osseous, that we need not follow it up for our analogical purposes.

Attention may here be called to the analogy existing between the porous, earthy, aërating materials, often intercalated between the strata of more solid rock, in the mineral world; the cellular tissue of the lamina forming the parenchyma of the leaf in plants; and the cellular, areolar or continuous tissue, (external and internal,) forming a nidus for the deposit of all the molecules of the body, and circumscribing each organ in the animal kingdom.*

It may not be irrelevant, before closing this chapter, to call attention to the fact that, although the analogy between the inorganic structures and those of the highest organisms may not be so apparent, at first sight, yet, if we can establish it with reference to the lowest organic structures, we can readily trace the others upwards; especially as we find something analogous to the lowest even in man, the highest.

Thus, let us compare the lowest breathing apparatus—where the white sanies is simply aërated by contact with water in a general cavity—with man's connective tissue, above described, and its serous fluid, permeating every interspace, as shown in emphysema, when external air is admitted; and the resemblance is greater than when the same parenchymatous structure is developed into the complicated and delicate lung. The intermediate grades, designed to promote respiratory action, are observable in the insect-tracheæ, with elastic spiracles; next in the investing pallium or mantle, (as among the brachiopods,) forming a breathing tuft, which afterwards we find in more distinct branchiæ among the lamellibranchiate mollusks and tubulibranchiate worms, the fishes, and some batrachian reptiles, (menobranchus, etc.;) while the true pulmonic sac is first seen among the pulmonate gasteropods, the pulmonic insects, (as some spiders,) among some reptiles, the birds, and the mammalia.

Again: compare the homogangliate nervous system of the Articulates with the thoracic, intercostal, ganglionic system in man; or the heterogangliate nervous system and œsophageal ring with

* Horner's Anatomy, vol. i., p. 322.

the abdominal solar plexus, etc.; the agangliate, radial, nervous filaments with the interganglionic communications of the great sympathetic; or even the insensible substance of the brain itself with the neurine of some Radiates: the only nervous system, if they have any, of the lowest Invertebrates. Are not the whole the analogues, partly of our involuntary nerves, presiding over the vegetative functions, partly of our voluntary nerves, for the admission of ideas and knowledge through our senses, or for the transmission of power for muscular, locomotive, and other purposes?

To one more law of nature it may be admissible here to advert: the tendency to a bilateral structure and to a repetition of similar form in different organs.

A median line, drawn from the vertex of the human head, perpendicularly, to the heels, divides the body into two halves, in either of which may be found nearly all that we find in the other. The brain (with its two cerebral hemispheres, divided by the intromission of the falx cerebri, a membranous reduplication of the dura mater, its cerebellum, and spinal cord with bilateral nerves) bears an external form having some points of resemblance in common with the double lungs, partially separated by the mediastinum, (reduplication of the pleural lining,) as well as to the double heart, venous and arterial, with its arteries and veins: the first set of organs distributing the nervous, the last the hæmal fluid.

Even the stomach, situated between its biliary and pancreatic organs, continued into vermicular appendages of absorption and excretion, is constructed on a plan not altogether unlike that of the previously mentioned systems.

In the pulmonic circulation of man we have the venous blood purified and sent to the left side of the heart; in the systematic circulation, we have the aërated blood depositing its nutritive materials and returning as vitiated venous blood to the right side of the heart. Among the lowest animals we have no walls to separate the materials of nutrition from the water of aëration. In more advanced organization we have the white blood, destitute of its red globules, typifying our chyle in the lacteals, and our lymphatic system generally; then we have the pulsating tube, representing the heart; later we have an oval viscus, containing a single cavity; in more advanced organization, we see a heart with one auricle and one ventricle, as in the fishes, resembling the right side of our own;

then in the reptiles we observe a single compartment added on the left side, while the birds and mammalia share with ourselves the double circulation due to the four compartments.

The gradual changes which the osseous system undergoes may be traced through the different departments of the animal kingdom. Among the lowest, it consists chiefly of an exoskeleton, the analogue of our dermal system and appendages, with, however, even in some polyps, the rudiments of an internal or endoskeleton; again, among the echini, some brachiopods, and in the teuthidean cephalopods, (cuttlefishes,) we have these rudiments more developed, until, among the cartilaginous fishes, we have the true form of the vertebrated endoskeleton. As yet, however, the chief organic chemical constituent is chondrin, a modification of that gelatin* which forms the animal matter in the bones of the mammalia, and which, converted by oxygenation into albumen, predominates in the exoskeleton of the Articulates, and in some pulmonate mollusks. While the earthy matter prevails in the shell of the bivalves, the gelatin is still found in the leathery integument of the mammalia, but has become albumen when detected in the epidermal covering and its appendages, hair, nails, etc. Throughout the whole skeleton the dual type is seen still to prevail.

Thus, too, the earth has its tendency to bilateral structure, as indicated in Chapter I.; it has also its hard crystalline central materials, sent forth by volcanic fires to the surface, and modified, by diminished pressure and other circumstances, into porous vesicular rocks, as the endoskeleton is modified into the less solid exoskeleton.

It is by no means contended that this earth is a monstrous organism, with all the parts and properties of a plant or animal; but simply, that in it we have every thing developed according to the same laws and plan pervading the rest of creation; that in it we see foreshadowed the type of those future forms and changes which organic bodies undergo by the assimilation of these very inorganic materials; in short, that "of dust we are made, and unto dust we shall return."

In conclusion, I ask permission to give the testimony of authority which, had I seen it sooner, would have yet more encouraged me.

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* Silliman's Chem., p. 518.

When I had developed these views, as stated in the preface, during a summer course given to the medical students and seniors in the Literary Department, one of the students, who owned a copy of Prof. Guyot's "Earth and Man," brought it to me, and I then, for the first time, learned that I had such high sanction for pursuing my investigation. One passage I give verbatim from page 114. When speaking of the gradual formation of continents, Prof. Guyot says: "If we cast a glance back upon the way we have just passed over, do we not, gentlemen, recognize a striking analogy between this successive formation, first of our solar system, then of the continents and the beings inhabiting them, and the formation of the animal in the egg? Is there not here the same law that we have recognized everywhere else? Do we not see, first a homogeneous fluid, then the appearance of elementary organs at several points; finally their definitive combination in an organic whole?"

Thus, then, having endeavored to work out the problem of analogy between inorganic and organic structures, our next duty is to trace the peculiarities in the vegetable world, to which the inorganic differences of successive geological periods give rise.

CHAPTER IV.

Botanical Geology: exhibiting the predominant Flora and peculiar vegetation to which the different geological strata give rise.

HAVING already stated my want of acquaintance with the minute details of Botany, it will not be expected that I should do more than point out, in general terms, the prominent differences observable as well in the fossil flora as in the vegetation of the present day, while we pass from one geological period to another.

This chapter will, therefore, chiefly consist of an elucidation of the eighth problem laid down in the Introduction, on page 25, in the following words:

VIII. Among the fossil flora, as well as in recent vegetation, we have proof that the growth of different periods acquires some of its peculiarities from the greater amount of a given material predominating through that period. Thus, in the earlier geological formations, the vegetation, fossil as well as living, consisted and consists chiefly of plants exhibiting a simple cell-structure, the cellular cryptogamia, while phænogamia are rare. But at a later geological period, when these cells have been aggregated into tissues and coiled into spiral tubes, we have the vascular cryptogamia; while, as the cells of nutrition and of reproduction become specialized, (as when the geological aqueous deposits furnish more abundant materials for nutrition and reproduction,) the phænogamia of one or two seed-lobes shoot, under more genial skies, into caulescent shrubs and into trees of multicentennial trunk-growth.

It has already been intimated that we find more of the crypto-

gamia among the earlier geological formations than we do of the phænogamia; let us examine the probable cause.

During the early geological periods, when the primary hypogene rocks predominated, and when probably there was no nitrogenous atmosphere and no aqueous deposition, there was very little material, if any, for the nourishment of plants. If any grew, they were destroyed by fire; and it is only in the earliest aqueous deposits that we find them. Such as are found fossil in the limestones of the Silurian seas were chiefly marine plants, fucoids and other cryptogamia, of the simplest cell-structure; (see the genera Palæophycus, Buthotrephis, Scolithus, and Sphenothallus, in Prof. James Hall's Palæontology of New York, among the splendid contributions to Natural History so liberally brought out by that State.)

In the Devonian period we have few plants; but in the Carboniferous, when there was evidently a considerable amount of dry land, and an abundant supply of carbon,—when perhaps, too, the regions, now temperate, where we find fossil palm-trees, as in the coal-field of Indiana, were some twenty-three or four degrees nearer that portion of the globe on which the sun's vertical rays descended,—we find those vast deposits of vascular cryptogamia, such as ferns, calamites, sigillaria, lepidodrendra, etc., and the monocotyledonous phænogamia, coniferæ, and palmacites, which formed or are associated with our coal-beds, of vast economic value.

In the New Red Sandstone we have the Voltzia, etc.; and it is only among the Tertiary and later formations that we find fruits, leaves, stems, etc., of the dicotyledonous phænogamia in a *fossil* state.

The *recent* vegetable products of the above geological periods differ from the fossil, partly because the climate has altered, partly no doubt because the decayed vegetation was doubtless often carried from an earlier geological period, with its sand, detritus, etc., into the yet plastic materials of a later geological date, there to be fossilized: just as a tamarack (the American larch) might be transported from the head-waters of the Mississippi, and finally stranded on the coast of Guadaloupe, to be fossilized in the now-forming limestone of that island.

It is true the date of both, in this case, would fall within the same geological period, the recent; but it might be otherwise, if

that tree were "a Baobab, vegetating before the foot of man trod the earth."*

Upon examination of Map No. 2, calling to our recollection the vegetable products of the different regions, we cannot fail to observe that at the present day we find more mosses and other *cellular cryptogamia* in the region of Lapland, Iceland, Hudson's Bay, etc., than farther south; also, that between the lines B^{I}, B^{II}, etc., and C^{I}, C^{II}, etc., we find, near the former, some *vascular cryptogamia*, and that the *smaller monocotyledons*, not indicated on the map, as the grasses and cereals, besides coniferæ, are also abundant; whereas farther south, along the latter-named lines, we find *dicotyledonous* forest-trees the most universally diffused.

When we travel still farther south into the Tertiary, the plants included under the name exogens are found to diminish, and we have large endogenous canes, as maize, sugar-cane, bamboo, etc., containing silex in their epidermis; also, palms and cycadæ; as well as gigantic cryptogamia, with their petioles now developed into tree-stems, such as the tree-ferns and club-mosses.

To recapitulate, we find in the present *Azoic regions* a predominance of the simplest cell-plants, denominated thallogens, as the lichens, seaweeds, liverworts, and fungi, abounding in mucilaginous products, and usually in soda salts. In the *Protozoic* period we have the vascular cryptogamia, ferns, mosses, club-mosses, and equisetaceæ; also the smaller endogenous plants, as the grasses and cereals, rich in starch of the same chemical constitution as the gum. In the *Mesozoic* period the starch has been converted into sugar in the dicotyledonous development of plants and of their fruits; while the salts in the residual ashes are chiefly potash. Finally, in the *Cainozoic* regions we have many large monocotyledonous trees, and still farther south vascular cryptogamia again, but now of gigantic tree-growth. During this period not only are the acids abundant, such as tartaric, citric, tannic,† etc.; but the stimulus of light and heat has developed the various coloring and pungent products, such as the dyewoods and dark timber, (ebony,

* See Schleiden's Poetry of the Vegetable World, edition of Messrs. Moore, Anderson, Wilstach & Keys, Cincinnati, 1853, p. 55.

† I am informed by a practical tanner that the sumach of the South has much more tannin in it than the same weight of Northern sumach.

mahogany, logwood, Brazil-wood, indigo, etc.,) spices, oils, resins, camphors, balsams, milky juices, extractive matter, etc.

In the above advance from a lower to a higher organization, and in the elaboration of materials, we see readily that vegetation has partaken of the progressive development which we suppose the earth to have undergone. Not that I imagine an inferior organization to have developed into one more perfect, as maintained by some writers; but that the inorganic elements and active forces of one period were adapted for the growth of single-cell plants, requiring only air and moisture, when, at a later period, all the nutrition, light, heat, etc., were furnished necessary to develop the terminal, reproductive, pigment-cells. The same period has also produced the equivalents of the apophyses or limbs of the internal skeleton, in the form of abundant woody processes, as thorns or spines; as well as hairs, stings, and prickles, which are expansions of the epidermis, consisting of hardened cellular tissue,* the equivalent of hair, nails, horns, etc., on animals; while the glands† are minute bodies, also of cellular tissue, serving to elaborate and discharge the peculiar secretions of the plant, particularly when it is stimulated to increased action, as by the puncture of insects, which are led by instinct to form a nidus around their young, in the form of resinous lac, (stick, seed, or shell,) gall-nuts, etc.

That the deposition of material in the plant depends upon the stimulus of motion, resulting from the "active forces," is proved by an experiment made by Mr. Knight,‡ when "he confined a tree in such a manner that it could not be moved by the wind. The plant became feeble, and its growth much inferior to that of a similar tree growing in a natural state. Mr. Knight confined another tree, so that it could be moved only by the north and south winds, and obtained the singular result of an oval stem." This is in accordance with Axiom I., and dependent upon the same principle which increases the muscles of the blacksmith's arm, when, by volition transmitted along the nerves, he contracts and expands the muscular fibre, causing a greater flow of blood to those parts and a greater deposition of histogenetic or tissue-forming material, fibrin.

The arrest of the sap in the petiole of the leaf, in the acacia of

* Wood's Botany, pp. 25, 26. † Ibid, p. 26.

‡ See Mrs. Marcet's Conversations on Botany, vol. i. p. 114.

Australia, has already been alluded to. I am further informed by a traveller who visited that country, that the laminæ or blades, forming the footstalks of the leaves, and the leaves themselves, often have their planes vertical to, not, as in the petioles of our common trees, parallel to, the horizon. In this form of leaf there is usually no dissimilarity of structure in the two layers of the parenchyma, no epidermis with stomata. This is certainly in accordance with the placental type or intermediate position formerly supposed to have been occupied by Australia, previous to the separation of land now presented. If the inorganic materials be deficient for the elaboration of certain portions of the plant—as readily might happen, consequent on a horizontal separation of layers forming the earth's surface—how can those portions of the plant requiring such inorganic material be as fully developed as they otherwise would be? Even in a soil in which those materials once existed, too frequent growth of the same plant may exhaust the land of one or more necessary elements, and thus render it unadapted for nourishing that plant, although suited for others. Hence the advantage of rotation in crops. Hence, perhaps, the origin of our prairies, on the principle exhibited in Axiom XIII. Hence, too, the powerful effects of supplying, by manure or other artificial means, the lacking material—in other words, the effect of cultivation. "The crab* has been transformed into the apple, the sloe into the plum, flowers have changed their color, and become double; and these new characters can be perpetuated by seed. A bitter plant, with wavy sea-green leaves, has been taken from the seaside, where it grew like wild charlock, has been transported into the garden, lost its saltness, and has been metamorphosed into two distinct vegetables, as unlike each other as is each to the parent plant—the red cabbage and the cauliflower." Again: "In garden mould or compost the flowers of the hydrangea hortensis are invariably red; in some kinds of bog-earth they are blue; and the same change is always produced by a particular sort of yellow loam." * * *

"Mr. Herbert† has lately recorded the following experiment: 'I raised from the natural seed of one umbel of a highly-manured red cowslip, a primrose, a cowslip, oxlips of the usual and other

* Lyell's Principles of Geology, p. 566. † Ibid, p. 568.

colors, a black polyanthus, a hose-in-hose cowslip, and a natural primrose, bearing its flower upon a polyanthus stalk. From the seed of that very hose-in-hose cowslip, I have since raised a hose-in-hose primrose. I therefore consider all these to be only local varieties, depending upon soil and situation.' Prof. Henslow, of Cambridge, has since confirmed this experiment of Mr. Herbert."

Encouraged by these facts, I venture to ask, whether the vegetable products of a soil resulting from the disintegration of certain geological rocks would not be modified by those inorganic peculiarities; and also whether an idea, adopted before I saw the above statement, is sustained by sufficient evidence in detail? That the flowers of temperate zones (Secondary geological formation) are more frequently violet, blue, or green, than red or yellow; also the fruit, which is often a berry, nut, capsule, or a follicle, is small; whereas farther south (among the rocks and detritus of the Tertiary) we more frequently see large red or yellow flowers, with pungent, aromatic smell, and find the large fruit in the form of a drupe, a pome, or a pepo, (gourd;) and that at one period we have more force concentrated on æstivation and inflorescence, at another on fructification or the perfection of the ovary. In the seeds we chiefly find the nitrogen of plants; also the fixed oils; and it is only in some of the large pericarps that we find any good-sized cavities, which, Agassiz remarks, are peculiar rather to animals.* It is also in the pericarp around the seed, as well as issuing from the punctured bark, that we find many of the juices secreted from the cambium, such as the milky juice of the poppy, forming opium by evaporation; also that of the fig, the asclepias, (or milk-weed,) etc.

It is evident, too, that these thickened and solidified materials are, as we might naturally expect, soluble in the liquid obtained from them, and also usually in those mineral liquids which we suppose to be the analogues, or perhaps actually the same materials, fossilized or altered by subterranean, igneous, and inorganic proximities. Thus the resins, gums, camphors, etc., are soluble in alcohol, some in turpentine, etc., and some, as India-rubber, gutta-percha, etc., are soluble also in naphtha; just as the solid mineral bitumens are

* Agassiz and Gould's Prin. of Geol., p. 17.

soluble in the various forms of naphtha, and in the Breckenridge oil of Kentucky, or as stearine, spermaceti, and wax dissolve in glycerin.

Returning from these digressive observations, allow me to ask again if it does not appear that many of the previously mentioned diversities are produced by the greater amount of certain materials in one geological formation than in another, as well as by the greater stimulus of light* and heat as we approach the equatorial regions?

"The blue rays of the solar spectrum have most effect on the germination of seed; the yellow rays, which are the most luminous, on the growing plant."†

"The vitality of plants‡ is a chemical process, entirely due to the sun's light; it is most active in clear sunshine, feeble in the shade, and nearly suspended in the night, when plants, like animals, have their rest."

Such facts as these seem to furnish an affirmative answer to the above query.

Again: "Ammonia,§ the last residue from the decay and putrefaction of animal matter, rises into the atmosphere; but enough is brought to the ground by rain to supply the vegetable world. Ammonia enters plants by their roots, along with rain-water, and is resolved within them into its constituent elements, hydrogen and nitrogen. Hydrogen aids in forming the woods, acids, etc." . . "Nitrogen enters into the composition of most elementary vegetable substances; in short, a plant may grow without ammonia, but it cannot produce seed or fruit; the use of animal manure is to supply plants with this essential article of their food."

The existence of ammoniacal gas in appreciable quantity in the air is denied by some; but all admit the necessity of nitrogen for plants, which of course can be obtained from our atmosphere.

Mrs. Somerville confirms much that is claimed for the modifying influence of both soil and climate, when she adds: "Thus the decomposition and consolidation of the elementary food of the plants, the formation of the green parts, the exhalation of moisture by

* Plants we know absorb carbonic acid, appropriate the carbon and give off oxygen, under the stimulus of light, but reverse the operation to a considerable extent when that influence is withdrawn.

† Mrs. Somerville's Phys. Geogr., p. 322. ‡ Ibid, p. 320. § Ibid, p. 322.

their leaves, its absorption by their roots, and all the other circumstances of vegetable life, are owing to the illuminating power of the sun."

To this we must, however, add the various changes produced, under the *same* solar influence, so strikingly evinced in the experiments by Mr. Knight, quoted above from Sir Charles Lyell.*

Again Mrs. Somerville remarks:† "Vines have potash; plants used as dyes never give vivid colors without it; all leguminous plants require it, and only grow naturally on ground that contains it. None of the corn tribe can produce perfect seeds unless they have both potash and phosphate of magnesia; nor can they, or any of the grasses, thrive without silica, which gives the hard coating to straw, to the beard of wheat and barley, to grass, canes, and bamboos. . . . To bring the cerelia to perfection, it is indispensable that in their growth they should be supplied with carbonic acid for the plant, silica to give it strength and firmness, and nitrogen for the grain."

Here I would ask, in concluding this subject, on which I have already admitted my limited information, whether, of the four elements chiefly required for vegetable development, carbon, oxygen, hydrogen, and nitrogen, there is not in the full-grown plant proportionally more of the first in the ligneous framework, (the type of the osseous system,) more of the two next, as water, in the vascular system, more of the last in the final effort of the plant to perfect its seed (the reproductive system)?

Regarding the influence of electricity on vegetation, I refer the reader to Mrs. Somerville's admirable work on Physical Geography, (already so abundantly quoted from,) page 324; also to page 331 for the interesting fact observed by Prof. E. Forbes, regarding

* Every one in the United States must have observed how uniformly we have one set of weeds following another, after the settlement of a country; as the Jamestown weed (*Datura Stramonium*) exterminated by the Dog-fennel or May-weed, (Maruta; Anthemis of Linn.;) or one set of timber, as sycamore or black-jack, replacing in a waste field the original forest-growth, of perhaps oak, elm, maple, beech, etc. Doubtless certain seeds may lie dormant until the absence of soil-ingredient diminishes the growth of the predominant plant, and, by decay, furnishes other elements to promote the germination of its successor.

† Phys. Geography, p. 323.

"the primary floras and faunas having spread widely from their original centres over large portions of the continents before the land was broken up into the form it now has."

Some valuable statistics, chiefly furnished me by Dr. Blackie, of Edinburgh, showing the geographical distribution of various orders and families of plants, I propose placing for reference in the Appendix, and now proceed, in the fifth chapter, to examine whether the same laws influenced the distribution of animals.

CHAPTER V.

Zoölogical Geology: an endeavor to account for the peculiar Fauna characterizing different parts of the globe.

In the same manner as in the fourth chapter, we here begin by laying down the problem proposed in the Introduction, on page 25: That the same law which we applied to the vegetable applies to the animal world; for while microscopic animalcules, myriads of Radiates, (corals among fossils, acalephs now,) also of pteropodous and acephalous Mollusks, and of some of the lowest cartilaginous fishes, are comparatively abundant in early geological periods and in high latitudes, (not only as fossils, but as living organisms,) the highest Radiates, (echini and holothuridæ,) the highest Mollusks, (cephalopods,) the highest Articulates, (insects,) and especially the birds and mammalia, are proportionately much more numerous in the Tertiary period.

The Mammalia of the Post-Pliocene period have usually an excessive development of extremities and of dermal organs, formed from the latest serous layer.

Botanists have observed how much less arctic plants differ from each other on different continents than tropical plants do. So also zoölogists admit that the same animals inhabit the *polar* regions of the three continents.* "The animals of the *tropics* are not only different from those of the temperate zone, but moreover they present the greatest variety among themselves." "This diversity† upon different continents cannot depend simply on any influence of

* Agassiz and Gould's Principles of Zoölogy, p. 156. † Ibid, p. 157.

the climate of the tropics; if it were so, uniformity ought to be restored in proportion as we recede from the tropics towards the antarctic temperate regions. But, instead of this, the differences continue to increase; so much so that no two faunas are more in contrast than those of Cape Horn, the Cape of Good Hope, and New Holland. Hence other influences must be in operation besides those of climate—influences of a higher order, which are involved in a general plan, and intimately associated with the development of life on the surface of the earth."

Again, the same authors, at page 158, say: "The range of species does not at all depend upon their locomotion: if it were so, animals which move slowly and with difficulty would have a narrow range, while those which are very active would be widely diffused. Precisely the reverse of this is actually the case." On the same page they add: "The nature of their food has an important bearing upon the grouping of animals, and upon the extent of their distribution;" and on page 159: "Again, the peculiar configuration of a country sometimes determines a peculiar grouping of animals into what may be called local faunas."

In the same work it is stated, that "in the north we find clouds of birds presenting great uniformity in form and color, not one with brilliant plumage; also shoals of fishes, but not one with varied hues. The arctic fauna comprises whales, the lowest of mammals, aquatic birds, (the lowest order of that class,) no reptiles, few insects, but many minute crustaceans and some mollusks, chiefly belonging to the lowest acephalous type. Of the Radiates there are some jelly-fishes, and a few star-fishes, but no holothuriæ, and of the polyps none producing stony corals."*

The southern limit of the arctic fauna is not a regular line. "On the North American continent† it extends much farther southward on the eastern shore than on the western. From the peninsula of Aliaska it bends northwards towards the Mackenzie, then descends again towards the Bear Lake, and comes down to near the northern shore of Newfoundland." . . . "It‡ has been ascertained, that of one hundred and ninety-seven Mollusks inhab-

* This last fact seems explained, when we reflect that we have no limestone until late in the Metamorphic period, then somewhat abundantly in the Palæozoic strata, but much more so in the Cainozoic, the great region of recent stony polyps.

† Agassiz and Gould, p. 166. ‡ Ibid, p. 167.

iting the coast of New England, fifty do not pass to the north of Cape Cod, and eighty-three do not pass to the south of it; only sixty-four being common to both sides of the Cape." "A peculiar characteristic* of the faunas of the temperate regions in the Northern Hemisphere, when contrasted with those of the southern, is the great similarity of the prevailing types on both continents. Notwithstanding the immense extent of country embraced, the same stamp is everywhere exhibited. Generally the same families, frequently the same genera, represented by different species, are found. There are even a few species of terrestrial animals regarded as identical on the continents of Europe and America."

Had the explanations, or rather explanatory suggestions, which I propose offering regarding the differences found among animals in different regions essentially conflicted with the opinions of such men as promulgated the above, I might well have paused ere I ventured to print one sentence upon the subject. I well remember that to the kindness of Prof. Agassiz, in replying to my letters of inquiry, I owe the removal of some of my early difficulties in reconciling conflicting classifications. But the difference visible in the fauna of successive geological periods, as indicated on Maps 1 and 2, is, I think, in accordance with the views expressed in the above quotations; certainly it does not conflict with them.

That the Mollusks should differ north and south of Cape Cod was to be expected; because there the great ridge observed in sounding the Atlantic is the outcropping between the Secondary and Tertiary formations. That the southern limit of the arctic fauna should be somewhat isothermal, passing from Aliaska to Mackenzie's river, and thence descending to Great Bear Lake, is also nearly in accordance with the geological lines B^{I}, B^{II}, etc., separating the Metamorphic from the Secondary formations.

The naturalists, from whose work I have so freely quoted in this chapter, dwell especially† on the importance of embryology to the study of zoölogy, and of a classification adopted in accordance with the succession of organs in the embryonic development: founding the division into four great types on the organs of animal life first formed in the embryo; the minor subdivisions upon distinctions in the less important organs of vegetative life.

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* Agassiz and Gould, p. 168.

† Ibid, p. 123.

They contend also* "that there is a manifest progression in the succession of beings on the surface of the earth. This progress consists in an increasing similarity to the living fauna; and among the Vertebrates, especially, in their increasing resemblance to Man."

Does it not, then, seem to be in accordance with this great general plan of the Creator, that the animals found fossil in the earliest geological periods should resemble each other more than the same classes, families, and genera do in the later formations, just as embryonic Vertebrates, Articulates, Mollusks, and Radiates are scarcely distinguishable; and further, that the animals of those early periods should partake of the predominant materials and peculiarities characterizing our gradually expanding earth; while later animals partook of materials and peculiarities incident to periods of later terrestrial development?

Thus we have in the earliest periods no mammalia, birds, or reptiles, few cephalopods, insects, or holothurians; the very peculiar fishes of early geological formations (so patiently investigated and described by our lamented Hugh Miller) have developments of the encephalon, thorax, and anterior extremities similar to those of the early trilobites. Compare, for instance, *Pterichthys cornutus*† with *Eurypterus remipes*.‡ Both belong low in their class. Of the abundant brachiopods in the lowest class in the department of Mollusks, and a low order in the class of Acephals, we find among palæozoic fossils, chiefly such as have a very regularly radiated form in their shell, an equality in their valves, and nearly equal proportions in their sides. As a proof, let the reader recall to his mind's eye the *Lingula antigua* and others, the *Leptæna alternata*, *L. sericea*, etc.; *Orthis occidentalis*, *O. testudinaria*, and a host of other species belonging to the same genus, in the Silurian seas; the Orbicula, Spirifer, and Terebratula; the few gasteropods we find are also regular, such as Murchisonia, Pleurotomaria, Bellerophon, etc.; and the rarer cephalopods are represented chiefly by the straight form of Nautilidæ, the common *Orthoceratites*, (*Orthoceras*, *Endoceras*, *Ormoceras*, *Cameroceras*, etc.,) with, later, an occasional *Cyrtoceras* and *Gyroceras*.

The representatives of the crustacean Articulates of those early

* Agassiz and Gould, p. 205. † Ibid, p. 194. ‡ Ibid, p. 193.

periods are also symmetrical, as *Calymene Blumenbachii*, *Isotelus gigas*, *Ceraurus pleurexanthemus*, *Homolonotus delphinocephalus*, *Trinucleus concentricus*, *Phacops callicephalus*, etc., or the one-eyed *Cytherina Baltica*, found in the Lower Silurian, near Frankfort, Kentucky; also the later trilobites, *Brontes flabellifer*, *Phacops macrophthalma*, and *Phillipsia seminifera.*

Regularly radiated crinoids are found in the Palæozoic formations, such as *Cariocrinus ornatus*, in the Upper Silurian; *Olivanites Verneuilli*, in the Devonian system; *Platycrinus* and *Poteriocrinus*, in the Carboniferous; as well as the armless and stemless* crinoids,—perhaps an intermediate link† between them and the echinites,—*Pentremites;* and the true echinites, *Cidarites Nerei*, *C. Munsterianus*, etc.

The Lower Silurian seas teem with symmetrically radiating corals, as the *Favistella stellata*,‡ *Favosites petro*, *Chætetes lycoperdon* or *petropolitanus*, *astrofavosites*, various forms of cyathopylla, etc.; the Devonian is replete with *Favosites polymorpha*, *F. Gothlandica*, *F. basaltica*, and yet later, the genera Gorgonia, Amplexus, Michelinia, Columnaria, Caryophyllia, depicted in the valuable quarto of DeKoninck, illustrating the carboniferous strata of Belgium, are of the same regular radial type.

But already in the Devonian system we begin to see traces of that want of perfect equality in the valves, sides, etc., alluded to above, which becomes still more evident in later formations. Thus we have the *Calceola sandalina*, *Pleurorynchus* (Cardium) *Uralium*, *Spirifer ostiolatus, and Sp. cultrijugatus;* later we find *Productus semireticulatus*, *P. punctatus*, etc.; *Sp. cuspidatus*, (Verneuil;) and in more recent formations the genera *Avicula*, *Ostracea*, (especially *Gryphæa*,) *Trigonia*, and the still more singular and more anomalous *Hippurites* and *Sphærulites*, in which, per-

* In using this term I may be mistaken, as Dr. Mantell states they have supporting columns. I can only say, among the numberless specimens I have seen from the Carboniferous formation, I never found, or heard of one being found, with the stem *attached.*

† An intermediate link between the crinoids and the star-fishes, such as the recent Comatula furnishes, is the Marsupites, (Medals of Creation, vol. i., p. 329,) found in the chalk.

‡ The reader will pardon me if I select my illustrations rather from genera and species abundant in the Middle States, with which I am best acquainted, than from specimens probably more common elsewhere.

haps somewhat as in our modern *Aspergillum*, the valves develop into tubular extensions.

In these later periods we find also, chiefly, the large spines, of which we saw traces in the productus and chonetes of the earlier formations. But especially do we, in the latest formations, find ample evidence that the materials were furnished in great abundance which developed both endoskeleton (the apophyses, as limbs) and the exoskeleton, dermal and dental, in the reptiles, birds, and mammalia, such as are exhibited in the saurian, chelonian, and batrachian reptiles, and in the gigantic birds of the Mesozoic period; but more especially in the *Basilosaurus*, (a gigantic cetacean,) the *Palæotherium*, *Anoplotherium*, *Megalonyx*, *Megatherium*, *Mammoth*, *Mastodon*, and many other mammalia of Cainozoic birth.

So too, at the present day, we find in those regions the armadillo and chlamyphorus, with their hardened epidermal cases, the giraffe, camel, elephant, rhinoceros, babyroussa, etc., and even the insects, with elongated or largely developed portions of the body, limbs, or dermal system.*

Is it accidental that in the Western Continent the monkeys should be able to use the tail as a valuable prehensile organ and have no cheek-pouches, while in the Simiadæ of the old world we find no tail among the apes, but enormously lengthened anterior extremities; cheek-pouches and callosities on the monkeys? Is it not in obedience to certain fixed laws that we see the tail and posterior limbs of the kangaroo enormously developed, while their fore-limbs, as well as the wings of several gigantic birds in Africa, Australia and New Zealand, are reduced to mere rudiments?

Was there not in the *earlier* stages of geological development, and is there not even now in their detritus, a greater amount of material, a greater energy directed to, and a greater typical development of, cephalo-thoracic organs and anterior parts, while in the *later* geological developments we find materials and force to elaborate in the animal (as we found in the vegetable) world greater ~e of abdominal organs formed from the mucous layer, more tendency to development of posterior limbs and of tegumentary and

* The calcareous framework of a bivalve mollusk, the Tridacna of the Indian Ocean, is said occasionally to exceed three hundred pounds in weight.

dermal excess; while in Australia we have an excess of the placental type, exhibited in the transformation of part of the mucous layer into an extra-uterine pouch?

Is it by accident that we see in the Carboniferous period, when the land had emerged from the Silurian and Devonian seas, the spiral vascular tissue (as well as the verticillate, alternate, periodical development along the nodes of the axis) in the vegetable world, imitated in the spiral axis of the *Retepora Archimedes*, in the columella of the abundant spiral univalve gasteropods, and in the elongated, numberless joints of some reptiles?

Surely there is a design, a great law in all this;—but we may well pause, in humility and awe, to ask whether it is permitted to finite mortals to penetrate this as well as other portions of the veil which Omnipotent Intelligence has cast around His dread arcana.

Much more might be written on this interesting and important branch of the subject; but, in accordance with the plan adopted, any details thought somewhat important, but yet not absolutely essential to, or even marring the continuity of, the reasoning, will be placed in the Appendix.

After examining one or two points which escaped attention above, we shall proceed to sum up the evidence and close the chapter.

In Australia, where there are one hundred and seventy* species of Marsupials, another most remarkable feature of the fauna is, that "the same types† prevail over the whole continent, in its temperate as well as its tropical portions, the species only being different at different localities."

The placenta is the medium of communication between parent and offspring. Animals, therefore, of a placental type would partake of characteristics indicating that communication. In *Mammals*, even after birth, the connection between parent and offspring is kept up some time by the umbilicus, and by the necessity for the young animal to draw nourishment from the maternal mammary gland. In *Birds*, the egg is deposited so as to have no communication with the maternal cavity, but, instead of being abandoned to chance, is carefully hatched to maturity, and the brood protected by the mother's warmth. The *Marsupials* seem to offer an inter-

* Fitch's Phys. Geogr., p. 188.

† Agassiz and Gould, p. 171.

mediate grade between the two: the offspring being consigned to extra-uterine life at an earlier stage than is usual among mammals; but being kept warm and nourished in the enormous development and sack-like reduplicature of the nipple integument.

In the singular subdivision* Monotremata, the claims of which to a place among true mammalia have been settled—as well as many similar important questions and doubts—by the consummate skill of Prof. R. Owen of London, in the department of Comparative Anatomy, we find a grade of mammals approaching—in the form of the beak, in the resemblance of the clavicle to the furcla (merry-thought) of birds, in the spur on the hind-foot of the male, and in the imperfect state in which the young are produced—very closely to the birds; and yet having mammary glands and the duck-billed lips, flexible enough to be used as an organ of suction, and thus claiming to be mammals. Do not both these singular orders of animals represent an organization indicative partly of the intro-uterine development, in which communication is fully kept up between parent and offspring, and that in which all connection is gradually but finally broken by extra-uterine life? The subject is at least worthy of consideration.

To sum up now, we seem to have a climatal region or geographical range for each animal. The boundaries of those ranges frequently coincide with geological changes from one formation to another. The lowest animals, as regards organization, of each smaller and larger group, the lowest genera of an order, lowest orders, lowest classes, and lowest departments, are more abundantly represented in the early geological formations than in the later; more in the boreal than in the austral regions.

In the former countries are also more prominent, in animals, the organs which appear first developed in embryological existence; whereas in the latter countries we find the higher groups, orders, classes, and departments, also the organs resulting from the later embryological developments of the mucous layer, much more abundant and striking, as well as the posterior limbs and the

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* Considered by some a separate order. See Dr. Reese's Zoölogy; Chambers' Course, New York Edit. of A. S. Barnes & Co., 1858, p. 126.

accompaniments of the dermal system.* We see frequent evidence of the animal partaking of the physical type of that portion of the terrestrial matrix in which it originated; and yet it does not follow that all originating in the same region must partake of the same character, any more than that the children of the same parents necessarily closely resemble each other: there being always a thousand modifying circumstances to give pleasing diversity, under one general law and unity of plan.

Leaving to the naturalist this important subject,—important in the practical inferences to be drawn,—with feelings of anxiety and humble inquiry, I cannot, however, say really with misgivings,—I approach, in the sixth chapter, a part of the subject yet more interesting and more important, inasmuch as the life and welfare of those who claim to be sentient, reasoning beings demand more attention than those to whom few, if any, of those attributes are accorded.

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* It is among the mammals of the tropical countries, also, that we find the odoriferous materials, secreted by glands, usually situated in the abdominal region.

CHAPTER VI.

Anthropographical and Ethnological Geology: offering some explanation of the differences found in Man at various points and periods on the globe.

If we ever found or heard of indigenous races of black-skinned, crisp-haired, flat-nosed, prominent-heeled races inhabiting, along with the white man, countries in high northern latitudes; or ever saw very fair-skinned, oval-faced, highly susceptible and intellectual races evidently laying equal claim with the negro to the original possession of some equatorial region, we might doubt whether physical causes had produced those diversities.

But as we do not find the Juniper-berry or Bass-wood (Linden) at the equator, nor the Cocoa-nut or Ebony under the frigid zone, so we never find pure white races who have from time immemorial inhabited equatorial regions, nor pure black races of men whose traditions point to an arctic origin.

On the contrary, we observe, by glancing our eye over the large printed Tabular Diagram accompanying this work, that in the extreme north, although, from excess of exposure, cold, filth, fish-diet, etc., the skin is not very white, yet not only the general physical configuration more nearly approaches that of the pure white races, but the mental powers, and restlessness under restraint, are very similar. And, as a general rule, the more we approach to the Secondary Geological Formation of country, the more the superior qualities of the Human Race will be developed. In that formation they will be at their height: the due balance of physical, intellectual, and moral powers will be found most perfect; and as we pass from that into the Tertiary, those qualities of mind and

morals, and some powers of the body, (such as those dependent on the vascular system,) will gradually diminish in force, while the animal passions, the terminal pigment-cells, and the organs formed from the mucous layer, as well as the lower limbs, will generally be increased in size and activity, as well as the quantity of the biliary and odoriferous secretions. The manners, customs, forms of government, and of religion, will all be modified by these various circumstances, and partake of, or rather constitute, the national character.

The reader may here, probably, feel disposed to ask: Can, then, difference of climate have power sufficient to produce the infinite ethnological diversities visible on the earth, physical, intellectual, and moral? This is by no means claimed. The different inorganic materials taken, through the medium of plants and animals, into the human system; the impressions made on the organs of special sense by the physical geography of a country; the greater or less power of the sun's rays, from the more or less direct and lengthened exposure to its power, all operate as modifying agents.

To prove then the above, somewhat as laid down in Problems X., XI., and XII., is the task to be performed in this chapter.

In endeavoring to carry out the duty assumed, it may render the remarks more intelligible if we confine ourselves first, in accordance with the heading of the chapter, to the anthropographical portion, which, besides giving a description of the human race, "treats* of its distribution, as distinguished by physical character, language, institutions, and customs; in distinction from ethnography, which treats historically of the origin and filiation of races and nations." Commencing with the white races, usually termed

THE CAUCASIAN VARIETY,

and examining them *physically*, we find, particularly among the Jews, Greeks, Italians, Armenians, Caucasians, Georgians, and Persians, regular, usually oval features, straight dark hair and dark eyes, high forehead, often aquiline nose, and commonly a moderate-sized, well-proportioned figure. As we diverge from this central region farther north, even where we encounter races claiming to be of the same origin, we find less symmetry of face, but the same dark hair and eyes, for instance, among the Spanish, Portuguese,

* Webster's quarto Dictionary, p. 58.

southern French, southern Sclavonians, etc., until, somewhat farther north, as among the Swiss, we have brown hair and hazel eyes; and a little farther from the centre of dispersion, the oval face gives way frequently to the high cheek-bone; the eye has become usually blue and the hair light, especially in youth. These peculiarities we note, for example, among the northern Teutonic races, the Anglo-Saxons, the Scandinavians, the Hollanders, and the Russians.

The *intelligence* of the races—judging from the amount of enterprise, activity, discoveries in arts and sciences—increases as we go upwards from the centre, until we pass beyond the *Secondary* into the Primary Hypogene or arctic regions, and there appears to diminish, although the great acuteness of the North American Indian, of the Esquimaux and Laplander, in the use of the organs of special sense, and their indomitable love of independence, may induce us to ask whether this apparent deficiency of intellect is real.

The *moral faculties*, indicated by the monogamic relations, the forms of government, and the prevailing religion, will generally be conceded to attain their greatest eminence in the *countries of Secondary Geological Formation;* while, on the other hand, in *Intertropical Countries*, these forms partake more of the influence exerted by the animal propensities.

We take next, as furnishing the most marked contrast, the races forming the descending radii of dispersion from the above assumed central point, namely,

THE NEGRO OR ETHIOPIAN VARIETY.

Again, as before, we examine them *physically*, and we find a downward tendency throughout, similar to that in the descending axis or root of the plant. The forehead is low, hair grows low upon it; nose is flattened, mammæ pendent, abdomen, and the glutæus magnus and other muscles, often protuberant, lower limbs frequently long, and the heel projecting.

The development of the pigment in the cells of the rete mucosum, or lowest and most recently-formed portion of the cuticle, next claims our attention. It is true* "that an imperfect introduction of oxygen, as in hot climates, causes the arterial blood to assume a

* As stated by Dr. Draper, in his admirable work on Physiology, p. 112.

dark color;" but one great, if not the chief, source of the dark color of the skin, is indicated in the following extract from Dr. Draper.* After describing the netted appearance which the rete mucosum presents, originating in the eminences of the papillary structure below, he adds: "Many of its constituent particles contain coloring-matter, especially in the dark races. The pigment seems to be produced by the agency of the sunlight and continued high temperature, though it disappears gradually as the cells containing it approach the surface. It yields a very large per centage of carbon."

One suggestion, as to the probable source of this carbon, may be made in this connection. Under certain circumstances of disease, as in jaundice, the abnormal increase and diffusion of bile carries it in such a manner to the dermal system as to give to the skin and eye a decidedly yellow hue, very similar to that of some of the Mongolian race, or the mixed negro and white, the mulatto. Some persons, who have had this disease, retain through life a peculiar odor,—perceptible when the excretion from the skin is active, observable also, in susceptible persons, under great mental emotion, particularly of anger,—similar to that which almost any olfactory nerves can detect at all times as a natural exhalation from the skin of the Ethiopian variety. No one can doubt that in warm climates there is a greater elimination from the blood, through the medium of the liver, of the materials constituting this bile, than exists under less stimulus of light and heat. The bile is a hydrocarbon, and although, under less stimulus, the nervous energy may not arouse such an over-abundant supply as to throw a portion into the absorbent system, yet in tropical climates, where this action has been kept up through long successions of generations, it is possible that one source of the carbon in the rete mucosum may be due to its retention during the dermal excretion of waste-blood materials, the gaseous products passing off more readily than the carbon, by exosmosis.

This seems not so improbable, after reflection, as on first consideration, especially after perusal of such observations as the following, from Dr. Draper: "I therefore† regard the bile as an excretion of materials which are decomposing and ready to be

* Draper's Physiology, p. 234. † Ibid, p. 203.

removed from the system. I incline to the supposition that much of it is derived from the cells of the blood, the life of which is only temporary; for the casein of the meconium" (fœtal bile) "is nothing but the globulin of the cells, the two substances being chemically allied, and the predominance of iron in the ash of meconium seems to establish a connection with hæmatin. Moreover, this opinion is supported by the remarkable stability of many of the nitrogenized coloring-matters, the analogies between hæmatin and chlorophyl, and particularly by the fact, that in the herbivora the coloring-matter of the bile is undistinguishable from chlorophyl, and in most other tribes closely allied thereto."

Some persons may object to the inferences drawn above, by remarking, that if the color of the negro skin were due to the carbon deposited in the rete mucosum, from one source or other, an old negro should be darker than a young one, inasmuch as the deposition would increase as life advanced. This is actually the case. Not only is the negro whiter when young than when he becomes old, but the same may be observed in the skins of white persons.

Again: the objection may be raised, that if the coloring-matter is due to the effects of great heat and light, negroes removed to a northern climate should become lighter. Even this might be the case. The short period during which the black race has been domiciled in the United States is insufficient to test this point.

The natural absence of high colors in the furs and skins of arctic animals seems to aid in establishing the above-assumed positions; while attention is also called, as corroborative testimony, to the fact that some animals, which in a wild state have dark skin and hair, when placed under the influence of domestic luxuriance, have their physical constitutions rendered more delicate and susceptible, (as is the case with the white man,) and are characterized by the lighter colors of skin, or sometimes by a mixture of both. This is particularly evident with the rabbit and the hog. A horse having a white foot and hoof, while the others are black, is proverbially known to the farrier and blacksmith as being more liable to disease in the limb in which white predominates, and as having the white hoof, from its softness, much more readily trimmed by the butteris.

On the same principle, namely, delicacy of organization, depends,

perhaps, the peculiarity of the albinos,* found among the white as well as the black races. The thinness of skin and fineness of hair, absence of any coloring-matter in the rete mucosum and in the hair, great susceptibility to light, so that its undulations produce an uncontrollable oscillatory movement of the eye, probably from the deficiency in the choroid coat to absorb excessive rays, all denote an abnormal peculiarity dependent upon the absence of material necessary for a well-balanced organization.

The same is visible in the vegetable world: while the plant raised in the cellar is whitened and sickly, the bright colors in inflorescence, under a tropical sun, the deep color of the late-formed true wood in the stem, the presence of pigments and of pungent aromatics in the sapwood, all denote that the energy of the plant is in those regions and at this period concentrated on the later products of growth. Even the ebony of extra-tropical Mexico† is less black and dense than that of nearly-equatorial Ceylon.

That even a single day's exposure to the direct rays‡ of the sun of the previously-covered white skin, say of the arm or neck, is sufficient to produce a powerful and disagreeable stimulus, and to leave the epidermis for some time of a darker hue, almost every one has seen or experienced in person. That this becomes permanent by a long residence in a tropical climate, many of our East-Indian adventurers and African travellers, etc., have proved. But, although the additional deposition of carbon during the escape of waste materials and the conversion of gelatin into albumen by oxygenation may be thus readily produced by the sun, the reäbsorption of the deposited carbon does not take place in the individual, and may not take place during some generations after the race has been removed from this tropical influence, just as other peculiarities become permanently hereditary.

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* Considered by some a distinct variety of the human race.

† I brought from Monterey, in Mexico, a specimen of tolerably solid, black wood, taken from a species of palm, which is there considered ebony: my want of sufficient acquaintance with botanical details prevented me from deciding whether the tree was the true *Diospyros Ebenum.*

‡ In Fitch's highly useful Outlines of Physical Geography, page 154, we find the following interesting estimate: "It has been calculated that, out of 10,000 rays falling upon the earth's atmosphere, 8,123 arrive at a given point, if they come perpendicularly; 7,024, if the angle of direction is 50°; 2,821, if it is 7°; and only 5 if the direction is horizontal."

As a proof of the first assertion, the non-reäbsorption of carbon from the lower layer of the cuticle in the individual, I would cite the permanent stain produced on the white sailor, or other person, when he thrusts carbon, in the form of gunpowder or of Indian ink, in the shape of an anchor, etc., by punctures of a fine needle, under the epidermis; or when the swarthy savage tattoos himself, to look darker and more savage.*

An interesting account is to be found in our highly valuable periodical, "The Scientific American," vol. xii., page 132, of a patent taken out to render dyes more deep and permanent; by which it is made to appear that "increasing the *density* of a material increases also the *intensity of its color.*"

If these arguments are admitted as regards the extreme color of the Ethiopian race, of course they will apply for the intermediate Mongolian and American Indian varieties. We shall therefore pursue this part of the subject no farther, but make some observations on the effects of the inorganic and organic materials taken into the system through the medium of food, solid, liquid, or aëriform.

Under this head should be included such materials, also, as are absorbed by the skin, a species of nutrition proved by imbibing soup or milk from a bath of those materials, during lockjaw, or some disease which prevents the usual process of deglutition.

On this subject we find an interesting article in The Scientific American, vol. xii., page 27, entitled,

"CASE OF GREEN COLOR OF THE HAIR.—M. Stanislas Martin has published in the *Bulletin de Therapeutique*, Paris, the curious case of a worker in metals, who has wrought in copper only for five months, and whose hair, which was lately white, is now of so decided a green, that the poor man cannot appear in the street without immediately becoming the object of general curiosity. He is perfectly well; his hair alone is affected by the copper, notwithstanding the precaution he takes to protect it from the action of the metal.

"Chemical analysis has proved that his hair contains a notable quantity of acetate of copper, and that it is to this circumstance that it owes its beautiful green color, which is most singular and remarkable."

* The whole of the seventh chapter of Draper's Physiology bears forcibly on this point.

The effects arising from the use of "Twiggs' hair tonic," (lac sulphur and sugar-of-lead in rose-water,) in restoring the natural color of the hair, is due probably to the stimulus and nourishment furnished to the pigment-cells in the hair-follicle by these inorganic agents.

Dogs raised in the neighborhood of lead-furnaces, as already alluded to, are rendered unfit for exertion, and become attacked by symptoms similar to those attending the "milk-sickness" of the Western States, also partaking of some of the characteristics accompanying colica pictonum, arising from the poisonous effects of the vapor imbibed, probably arsenious, or perhaps lead alone, or both combined.

The effects of mercury, in producing a lessened amount of fibrin in the blood, and its increased removal from the tissues, is such as to produce sloughing of the muscular, and finally carious degeneration of the osseous tissues.

That madder fed to animals is capable of tinging even their bones red, is stated in every elementary work on physiology; and that certain mineral and vegetable substances, taken into the stomach or introduced into the circulation, will pervade the whole system in a few seconds, is information too universally possessed to require amplification.

But it may not be so well known to the general reader, that there are certain substances, purposely or accidentally used as food, which sometimes produce powerful effects. Thus, in Mitchell's Therapeutics, page 666, we find the following account of the effects of ergot or spurred rye, which is generally supposed to be a parasitic fungus:

"The constant use of bread into which ergot enters is decidedly deleterious, and has proved to be so on a very broad scale. The grain has been promiscuously gathered, ergot and sound ears, the whole being ground into flour.

"In Silesia, a *dry gangrene* became epidemic from this cause, and raged in the years 1096 and 1588, being occasionally seen during the intervening years. Whitlaw, the author of a queer book on some new discoveries, says he detected ergot as the cause of a similar disease in this country, and especially in the State of New York, many years ago. And although some writers have boldly ridiculed the statements, they are neither, for that reason, unphilosophical nor false."

"The *Gazette Médicale*, 1844, has the case of a child, ten years old, in whom the ergot induced gangrene of the legs, demanding amputation. In a child twenty-eight months old, spontaneous amputation of the right leg ensued, and the child got well. The ergot was probably taken in food, but it is not so stated."

The long-continued use of arsenic, as, for instance, in "Fowler's solution," frequently produces dropsical symptoms. In the second volume of "Wood's Practice of Medicine," vol. ii., page 339, we find that "serous and cellular tissues pour out an increased quantity of fluid when excited. The excitement may amount to inflammation. That dropsical effusion is sometimes associated with this condition of the membrane from which it proceeds, is evinced by the symptoms during life, and the results of examination after death." . . . "An opposite condition of the tissues to that just mentioned may be productive of the same result, in relation to dropsical effusion. The vessels in debility sometimes become so relaxed, that the more liquid portions of the blood are allowed to pass through their walls, almost without resistance." . . . "Distention of the blood-vessels, unattended with irritation, frequently results in serous effusion." Altered condition of the blood and deficient absorption are also named, by the same author, as the immediate causes of dropsy: one or other of these five conditions must be induced by the use of arsenic, when anasarca is the result.

Many more similar cases might be added to prove the powerful effects occasionally produced by active agents introduced purposely or accidentally, commonly in small quantities and at remote intervals. These may, however, suffice to remind the reader of that which probably none will deny.

But when we endeavor to show that substances usually taken as articles of diet may or may not contain, in minute quantities, materials deleterious or beneficial, and that even some common food may, if used exclusively, be deficient in some ingredient essential to the well-being of man's body or mind, such an endeavor involves a more onerous task, and the chances of convincing are small, but by no means hopeless.

It is not sufficient, as counter-proof, to cite nations who, living almost wholly on potatoes, are physically healthy and strong; or others, who are long-lived on an exclusive rice-diet. To establish the point that these two articles, good in themselves, are all-suffi-

cient, it would be necessary to show that these nations exhibited the greatest amount of physical, mental, and moral power, combined in the most favorable manner; which is not the case.

An analysis of milk,* the natural food of many young animals, shows that it contains all the ingredients which are essential to the formation of the different parts of the animal system, brain inclusive; and nature in after life, from rendering us usually disgusted with the too long use of any one article of diet, indicates the desire and necessity for variety.

The fine, active, healthy bodies of numerous nomadic tribes, absence of physical deformity, added to the acuteness of some of their mental faculties, may furnish at least one argument in favor of the due change of air, water, and food, which is likely to result from their wanderings. Even when their diet, from day to day, is not very varied, on account of the sterility of the country, as among the Arabs and Tartars, their chief sustenance, milk, contains, as mentioned above, the elements necessary for developing all parts of the human system.

Intelligent dental surgeons have informed me of the great difference they find in the perfection of the teeth in different districts of country, and even between the inhabitants of town and country in the same region. This they attribute to the fact that persons living in the country generally use milk freely, which furnishes the necessary phosphates of lime and fluoride of calcium.†

Some persons may argue that if all the requisites are furnished during embryonic development, any ordinary article of food may afterwards be elaborated into materials for subsequent growth. But, in addition to the difference of those articles in furnishing on the one hand *histogenetic*,‡ or tissue-making, on the other, only

* Cow's milk, according to Prof. Silliman, Jun., page 527 of his Chemistry, contains water, butter, casein, albumen, milk-sugar, phosphate of lime, fluoride of calcium, chlorides of potassium and sodium, phosphate of iron and magnesia; also some soda.

† It is true the enamel of the teeth is not replaced when broken; but the material should be there in abundance to make that enamel (the third tissue, *encaustum* or *adamas;* see Owen on the Skeleton and Teeth, page 230) originally strong, and thus prevent its breaking easily and permitting the consequent decay of the other two consolidated tissues, the "dentine" and the "cement."

‡ Examine Dr. Draper's Physiology on this subject, chapters iii. and iv., especially page 63.

calorifacient food, we must remember that some very good common diet contains little else than starch, with woody fibre and water: a *waxy* potato does not even have much of the first-named ingredient.

Suppose we design depositing, by means of the galvanic battery, gold from its cyanide solution on a piece of bright silver placed in contact with the negative wire: could we continue long to obtain the necessary material, if we did not at the other wire suspend the necessary gold to supply the waste from the depositing fluid? Undoubtedly not. In the same manner some materials necessary for the perfection of the human system may have been supplied in such quantity that their want is not detected, even through a whole generation; but cut off that supply, or let very near relatives intermarry, and the double deficiency will soon show itself in the most marked manner. This point, however, we propose discussing more fully in the next chapters.

The causes of goitre, chiefly found among inland nations living on high mountains, and especially on the north side, may be, and are probably, very various; certainly, however, we are justified in saying, that the disease is less common among those nations using water and food containing small portions of iodine,* which would more usually be the case near the seashore, or near briny springs, than it is in districts far removed from that influence.

Scurvy—"a disease† in which the blood is depraved and the system debilitated, with a tendency to hemorrhage and petechiæ, and to local congestion, or feeble and imperfect inflammation in various parts of the body, but especially the gums"—is pretty generally admitted to arise from "the want‡ of fresh succulent fruits and vegetables, or their juices, which are supposed to furnish some principle necessary to the due constitution of the blood, and not to be found elsewhere, or, at least, nowhere in the same perfection."

There are other predisposing causes, but the want of fresh vege-

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* The effect of iodine and of bromine in reducing all glandular enlargements is too well known to require more than a mere mention. Iodine, it is also well known, is found in kelp and other seaweed; and is, along with bromine, abundant in some of the springs in the United States, originating in Secondary Geological Formations.

† Wood's Practice of Medicine, vol. ii., p. 258. ‡ Ibid, p. 263.

tables is pretty well proved to be the most frequent cause of scurvy, and furnishes strong evidence of the power of diet in deteriorating or improving the physical condition. Those who have read Dr. Kane's Arctic Explorations know the powerful effects produced both on the bodies and *minds* of the men by these scorbutic affections. I need only quote the following, from vol. ii., page 58: "Some were intensely grateful for every little act of kindness from their more fortunate messmates; some querulous, others desponding; others, again, wanted only strength to become mutinous. Brooks, my first officer, as stalwart a man-o'-war's-man as ever faced an enemy, burst into tears when he first saw himself in the glass."

If certain diseases can thus weaken the mind, does it not seem highly probable that such a diet as brings on these fearful symptoms might modify the powers of the mind, even before inducing overt disease?

Every one who has attempted mental labor must have observed that his mind is more clear when his diet is light and vegetarian, than after a heavy meal of animal food.

Some persons experience an over-excitement, inducing restlessness and sleeplessness, after drinking strong coffee; on some it produces even aphrodisiac effects.

We all know the diuretic effects of certain articles of diet and drink, and the intense irritation of certain gaseous or other products resulting from imperfect digestion.

A carnivorous animal, tamed and fed always on mild diet, remains gentle; but let him once taste flesh and blood, and he becomes ungovernable.

The rice-eating Hindoos are mild and inoffensive, opposed to the destruction even of the brute creation.

The savage warriors, who eat their own prisoners, increase thereby their own bloodthirstiness.

The blood and muscular fibre are readily assimilated, and give, no doubt, a more immediate supply of histogenetic material, and, perhaps, thereby a more immediate increase of muscular strength; but the mild, farinaceous, calorifacient cereals, and the saccharine fruits, furnish abundant strength for ordinary purposes, and many of the salts requisite; some fruits, as the peach, contain portions of one of the most powerful nervine agents at present known,

prussic or hydrocyanic acid, (C_2HN;) the lettuce, used freely, proverbially makes persons sleepy, from the narcotic principle it contains; codliver-oil and the alcoholic stimulants, from the quantity of carbon they furnish to neutralize the excess of tissue-destroying oxygen in the lung, are indicated as suitable in tubercular diathesis; and pure chocolate, from its mild oleaginous character, well supplies to the weak stomach a safe substitute for the stronger animal oils and fats.

"When* the expressed juice of vegetables is permitted to stand for a time, although it may have been clear at first, a turbidity sets in, and a flaky material is deposited. The substance thus possessing the power of spontaneous coagulation is identical in that property, and in composition, with animal fibrin. After its deposit, if the clear liquid be warmed to nearly the boiling-point, it again becomes turbid, and a second nitrogenized substance subsides, which, from its quality of coagulating by rise of temperature and its analysis, is inferred to be identical with animal albumen. When this has been separated by filtration or otherwise, and the juice is slowly evaporated, there come on its surface skins of a body having the same qualities as casein; so fibrin, albumen, and casein preëxist in plants."

"Fatty matters of every description may also be extracted from vegetable products. From leaves, seeds, bark, wood, etc., oleaginous bodies can be obtained by the action of sulphuric ether, which removes the fat and leaves it, on subsequent evaporation."

We need not, then, fear that a varied vegetable diet should deprive us of important materials of nutrition.

Having thus endeavored, briefly, to show the modifying effect which variation in diet produces in man, especially when continued from generation to generation, and pointing again to this as *one* of the sources, added to climatal and other causes, which produces a portion of the differences visible in races, and leaving the further discussion of this point, as before stated, for the next chapter, it becomes now our duty to follow up the periodical changes of nations, their origin, rise, maturity, and decline, and the appearance in those nations, at different periods, of men distinguished for physical, mental, or moral endowments. These considerations may be classed under the head of Ethnography, or

* Draper's Physiology, p. 36.

ETHNOLOGY.

Glancing at Diagram II., we see that the Egyptians, Assyrians, Phœnicians, Jews, etc., are placed near that portion of the Historical Tree from which growth commences, and that in the ascending axis we have, as taken from the best authority, the various nations who have successively possessed the greatest power and influence. It will readily be seen that this progressive movement has taken place on the globe somewhat in a north-west direction, and that the nations first mentioned, although still inhabiting the same countries, have evidently passed their prime; and the lithographer was therefore directed to represent those portions of the tree bearing their names as indicating that condition. Others, now in their prime, as Germany, France, and Great Britain, might be represented in full-bearing; while nations who, like North America and Russia, are expanding rapidly, might be typified by incipient blossoms.

I merely throw out these suggestions, and do not propose dwelling long upon them.

This progressive national development appears to have taken place in an upward direction from Palestine towards the Magnetic North Pole; also in a downward prolongation of the same line; and it has been observed by historians that prominent events often occurred about five hundred years apart. Whether this periodical national impulse arose from a greater amount of nervous energy infused by a greater amount of terrestrial energy, I leave for others to determine. (See Appendix, regarding influence of altitude, etc.)

The nations emanating from the above-mentioned original stock in a southern direction seem, like the root of a plant, to be of inferior quality, although largely endowed with the nutritive type; and perhaps may at some future day, by a change of circumstances, also change their character. The greatest amount of territory and power in the ascending axis seems destined to fall, in the Western Continent, into the hands of the Anglo-Teutonic race, and, in the Eastern Continent, ultimately, into those of one Slavonic branch of the ancient Sarmatians, the Russians. Thus, perhaps, the final struggle for ascendency—let us hope it may be one of virtuous emulation, not of bloody strife—will be between the "Great Russian Bear" and the "Anglo-American Eagle."

Here permit me to say, that it would be much more in conso-

nance with my own feelings to confine myself, in this essay, to such collections of facts as are susceptible of proof; but I do not feel at liberty to suppress suggestions which might eventually lead to practically useful conclusions.

I therefore am induced to call attention to the apparent prevalence of individual energy or endowments—which we noticed above in nations—developed apparently along particular geographical lines. If a line be drawn from Palestine towards the American Magnetic North Pole, the great majority of distinguished characters, particularly of antiquity, will, I think, be found to have taken origin in countries not very far distant on one side or other of this line.

Viewing the four quarters of the globe separately, perhaps the greatest number of distinguished men of more modern times, in Europe, were born near the Alpine Median Line, from Corsica up; those in America, not far from the meridian of 90° W. of the other, (say from 80° to 84° W. of Greenwich;) while the few who have signalized themselves in Asia, are to be found on the continuation of the same great circle, namely, about 90° E. of the Alpine Dissepimental Plane; and Africa has none at all.

Another region of force—infusing energy into animated life, at least in its northern portion—appears to exist along the edges of the developed tetrahedron exhibited on Map 1, especially on the line marked K, M, which, if the whole were accurately laid down, would, I think, pass through the Isle of Man, and parts of Scotland, where we have evidence of a strong disjunctive force, such as nearly separated Scotland from England, and produced various parallel partial separations, as along the lakes extending from the Isle of Mull to Murray Frith, or the nearly-united Friths of Clyde and Forth.*

Already, as a boy, I remember casting my eye upward from the base of the Cartland Crags,—that locality along the last-named line, so celebrated for its fine scenery, as well as for the shelter it afforded in its fastnesses to conceal and protect our celebrated hero, William Wallace,—and, after viewing its towering precipices, with

* Perhaps this same upheaving, disruptive force gave to the strata in England the general eastern dip, already observed by that astute geologist, Smith, the father of Palæontology.

a reëntering angle opposite every salient crag, wondering if it had not been rent asunder by some great terrestrial convulsion.

Although twenty-nine years have passed since I last looked upon that magnificent scene, and investigations point to the probability of such a rending asunder at some period of the earth's history, I am bound to admit that this is yet, at best, conjecture; and that I still view that cherished wonder of nature as a phenomenon replete with inquiry, and admirably calculated—along with volcanic upheavals visible near Edinburgh, on the same continuous line, such as the Castle Rock, Salisbury Crags, and Arthur's Seat—to impress the beholder with astonishment and awe, while contemplating such evidences of Divine Omnipotence.

CHAPTER VII.

Pathological and Therapeutical Geology: showing that diseases as well as appropriate remedies have some connection with the geological position in which they originate.

On page 26 of the Introduction will be found a statement of the problems to be solved in this chapter. The proposition is embraced in the following sentences:

XII. If in any soil there be a great preponderance of some soluble inorganic material, which is taken into the nourishment of cereals or other plants used by man, (producing, perhaps, an abnormal state of the plant, as in the fungus-perverted rye, ergot,) diseases of particular characters may be engendered in those using such productions as articles of food; and, *vice versâ*, if a man or race of men happen to be born and nourished where some material, essential to the animal system, is deficient in the soil and in the consequent vegetation, then the man or race of men will probably be liable to diseases resultant from such deficiency.

In northern temperate latitudes, there is greater energy of, and greater consequent liability to disease in, the cephalic and thoracic organs, including the nervous system; whereas in southern climes, there is more liability to diseases of the mucous layer, (abdominal, reproductive, etc.,) and of dermal excess.

XIII. In tracing the appropriate remedies, it is sometimes in other formations that we must seek the therapeutic agents to diminish excessive or promote defective action; but perhaps more frequently nature has placed within reach of each tenant of his own soil the appropriate remedy, which, by increasing the action

of the diseased organ, (or its absorbent aids,) causes it to excrete the excessive deposit of material not required to repair the periodical waste. Sometimes this is promoted by the vicarious action of another organ.

Confining ourselves, at first, to the consideration of the twelfth Problem, and refreshing our memories by reference to Axiom XI., regarding the organs formed from the different embryonic layers, let us examine what would be the result arising from an excess of material, or from great activity in any of the layers producing those organs; or, on the other hand, from a deficiency of material or of vital energy.

Would not the organ last formed from that layer be repeated in the first instance; and perhaps be shortened, or altogether wanting, in the second instance?

Thus, supposing an *excess* of serous layer forming nerves, bone, muscle, and extremities, might we not have, in the lower animals, monstrosities with double limbs, as exhibited in museums, etc.; or, in man, the family-peculiarity of six instead of five fingers or toes?

Would we not have, when the serous layer is *deficient*, instead of a fully-developed anterior extremity, the arm, a short one, with the hand near the shoulder; or, as happens more frequently in northern latitudes, a short posterior extremity, where the feet are near the knee? Both of these are undeveloped forms to be found in certain normal embryonic stages. Sometimes the deficiency is in the teeth, there not being material enough to complete this last portion of the skeleton formed from the serous layer. These defects are most likely to arise when first-cousins, or, yet worse, when double-cousins intermarry.

Again: the fissure of the lip may remain unclosed, giving rise to what is usually denominated hair-lip: a form existing in fœtal stage; or the hermaphroditic appearance of undeveloped organs of reproduction becomes apparent; or the stock dies out entirely, as happens, both among plants and animals, from continuing too long on the same soil, or being connected too closely by the ties of consanguinity in union of sexes.*

* Something of the same kind seems to occur when there is a marked *specific* difference between those uniting: thus, among mules and other hybrids, the sperma-

Nature has, when we do not violate her laws, provided ample materials to perfect her work; but if we contravene those laws, we must expect to suffer the consequences.

If a fowl is debarred from swallowing calcareous matter, or animal matter containing some lime, there may probably be a deficiency in the egg-shell, and a consequent deficiency in the bones of the chicken, which should receive calcareous matter by the thinning* of the shell during incubation.

If phosphate of lime and fluoride of calcium are already deficient in the osseous system of a family, and they continue to reside where none is furnished from the soil, through the medium of any of the materials used as food, or through imported articles used as diet, might we not naturally expect a deficiency in the bones and teeth of some of their progeny?†

In isolated villages, or on small islands, where little opportunity of variety occurs in nourishment, and where the intermarriages of relatives are likely to take place, we have frequent cases of idiocy, monstrosities, and defective organs of sense.

May not this abnormal condition be due, in the first instance, in a great measure to the *hypernormal* or *hyponormal* amount of each formative layer in the ovum, as well as, afterwards, to an excess or deficiency in the materials furnished through nutrition, particularly in early life, comprised under the various surrounding circumstances, inorganic and organic, of air, water, and food?

But must we not include with this the powerful influence which modifies the deposition of those materials, before and after birth, under the name of vital stimulus or nervous energy? This is undoubtedly dependent upon external impression transmitted along the nerves.

Thus, let the maternal brain be impressed constantly, especially in the early stages of utero-fœtal development, by some particular

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tozoa are wanting. Even the product of union between a European and an East Indian is said soon to die out, and the mulatto is proverbially scrofulous and unhealthy.

* Dr. Draper's Physiology, p. 35.

† An anomaly strikes me here, which may be explained as information increases: the valley of the Mississippi is noted for defective teeth, yet we meet fluor spar abundantly near the mouth of the Ohio, and at other portions of the region indicated.

influence, for good or evil, exerted on the centripetal or efferent nerves, or on the posterior (sensory) root of the cerebro-spinal nerves: does it, in such a case, seem at all unreasonable that a reäction should be produced on the plastic fœtus, forming it after the likeness of some cherished being, or marking it with some object of disgust or horror?

This may, perhaps, be granted, without admitting all that is claimed by some for the influence of the mother's imagination.

It is ascertained, by analysis, that the brain of an idiot, or even of a sane child, contains less phosphorus than is found in that of a well-developed adult. May not the idiocy, so often observed in the children of blood-related parents, arise from the phosphorus being deficient in the family system: that defect rendered doubly striking in the children?

Or again, as idiocy is sometimes the effect of conception during parental intoxication, may not the alcoholic stimulus have temporarily deprived the parental brain of some of its phosphorus, (by chemical combination of the hydrogen with the phosphorus, forming phosphuretted hydrogen, that, in extreme cases of habitual intoxication, gives rise, perhaps, to the combustion of the body,) thus producing an embryonic and fœtal deficiency?

The deficiency of silex in some soils, rendering the wheat-stalks too weak to support the grain, may point us to the possibility that Plica Polonica may arise from a want of silex, or of some other element necessary to give to hair its insensibility, added, perhaps, to too great activity of the vascular system.

Should the embryonic differences, alluded to above, be considered capable of producing diversity and peculiarity in the physical configuration and moral and mental power of the fœtus, it requires but little argument to show that the individual animal, young or matured, should have the system modified for health and strength, or for disease, of certain organs, by the nature of the nourishment taken, which nourishment, chiefly vegetable, must necessarily partake, to a considerable extent, of the inorganic materials in which it grew.

If capable thus of modifying an individual, such influences must be still more powerful when continued from generation to generation, giving rise to family and, finally, to national peculiarities, physical, mental, and moral.

For the purpose of examining this subject more minutely, I subjoin a tabular view of some prominent diseases to which man is liable, which, for our purposes, may be classed into those arising from excessive, and those from diminished action, in any organ.*

I also present at the same time, for the sake of comparison,—although, this being the pathological portion of the discussion, such a tabular view belongs strictly to the later therapeutical consideration,—a synoptical classification, arranged in one column or the other, accordingly as they have power, on the one hand, to increase, or, on the other, to diminish that action.

Before, however, examining these tables, it may be well for me to call attention for a moment to the well-known fact that, after all excessive action, there is reäction or deficient energy; that therefore, after too great action of the brain and nervous system, for instance, as when apoplexy takes place, deficient action or energy, as paralysis, is a frequent consequence; also, that many remedial agents may first incite to action, proving stimulant, and afterwards diminish that action, proving sedative, as opium, etc.

* It will be remembered that, according to Axiom I., where there is increased action there is increased flow and deposition of materials, at the expense, however, of some other material, from which these are derived.

DISEASES, OR ABNORMAL STATE OF THE ORGANS.

ORGANS.		HYPERNORMAL STATE.	HYPONORMAL STATE.
Cephalic.	Brain and its membranes.	Apoplexy, Cerebritis, Phrenitis, Meningitis, etc.	Paralysis, Idiocy.
	Spinal Cord.	Epilepsy, Tetanus, Hydrophobia, etc.	Chorea.
	Nerves.	Insanity, Monomania, etc.	Hysteria, Neuralgia, Rickets.
	Pneumogastric, etc.	Inordinate appetite? may arise from too great energy of this organ.	Want of nervous digestive energy?
	Sympathetic, etc.		
	Teeth, Gums, etc.	Toothache, etc.	Scurvy.
	Parotid Gland, etc.	Mumps.	
Neck.	Pharynx.	Inflammation of Fauces, Tonsilitis, Pharyngitis.	Putrid Sore Throat.
	Larynx.	Laryngitis.	
	Thyroid Bodies, etc.	Bronchocele, etc.	
	Bronchiæ.	Bronchitis.	
Thoracic.	Lungs, Tubes, etc.	Pneumonia, Phtisis, Bronchitis, etc.	Scrofula, (laxity of tissue,) Asphyxia, Asthma, etc.
	Membranes.	Pleurisy, etc.	
	Heart and its	Hypertrophy, Carditis, etc.	Atrophy of Heart, Syncope, want of vascular energy, Ossification; Angina Pectoris, etc.
		Fevers generally.	
	Membranes.	Pericarditis, Endocarditis, etc.	
	Also, Arteries.	Aneurism.	Ossification of Arteries.
	Veins.	Phlebitis.	Valves,etc.defective; Anæmia.
	Absorbents, etc., etc.	Lymphatic Consumption.	Anasarca.
Abdominal.	Stomach, etc.	Gastritis, Gastralgia, Cancer of Stomach, etc.	Dyspepsia, etc.
	Liver, etc.	Hypertrophy of Liver, Hepatitis, Splenitis, Bilious Fever, Jaundice.	Atrabiliarian diseases, Atrophy of Spleen, etc.
	Small Intestines, etc.	Typhoid Fever, Duodenitis, Enteritis.	
	Large " "	Diarrhœa, Dysentery,(Colitis.) Hemorrhoids, Prolapsus Ani, etc.	Hernia, Intussusception.
	Kidneys, Bladder, etc.	Nephritis, Cystitis, Retention of Urine, Diuresis, etc.	Incontinence of Urine, Calculi.
	Reproductive Organs.	Gonorrhœa, Leucorrhœa, Syphilis, etc.	Impotence, Sterility, etc.
		Spermatorrhœa, Priapism, Nymphomania, etc.	
	Uterus, etc., etc., etc.	Menorrhagia, etc.	Amenorrhœa,Dysmenorrhœa, etc.
Tegumentary and Locomotive.	Bones generally.	Brittle bones, from too much earthy matter.	Necrosis.
	Limbs.	Extra fingers, extraneous skin between fingers.	Frosted Limbs.
		Extra toes, corns, etc.	Chilblains.
	Skin, etc.	Burns, Scalds, Erysipelas, Elephantiasis, Rushes, Vesicular, pustular, scaly, tuberculated diseases.	Gangrene, Indolent Ulcers, etc.
	Hair, etc.	Plica Polonica.	Falling out of Hair.
	Teeth, etc.	Too rapid growth and decay.	Absence of Teeth.

REMEDIAL AGENTS, (THERAPEUTICS.)

ORGANS.			INCREMENTAL AGENTS. (TO INCREASE ACTION.)	DECREMENTAL AGENTS. (TO DIMINISH ACTION.)
Cephalic.		Brain, with its	Electricity, Alcohol, Ethers.	Assafœtida, Valerian, Musk, Castor, Garlic, etc., etc.
		various parts and	Primary effect of Chloroform and of some Narcotics.	Secondary effect of Narcotics.
		Membranes.	Camphors, Henbane, Belladonna, etc.	Absence of mental excitement; as late hours, novel-reading, play-frequenting, etc.
		Spinal Cord, with	Cannabis Indica.	Carbonic acid; sleep.
		its ramifying	Strychnia, etc.	Bleeding, Hemlock, Foxglove, Aconite, Nitrate of Silver, (in Epilepsy?)
		nerves and	Heat and	Hydrocyanic Acid.
		Ganglionic System.	Electricity.	Cold Affusions, Iodine.
		Parotid Glands, etc.	Sialagogues, as Mercury, etc.	Tinc. of Iodine, Tannic Acid.
Neck.		Glands, Tubes, Membranes, etc.	Squills? Calomel.	Iodine and Bromine.
Thoracic.	Respiratory System.	Lungs and their	Oxygen, Acetic Acid? Cold air.	Diminution of lung action and promotion of vicarious action of exhalants by removal to Southern climate; Inhalation of Carbonic Acid, diluted with common air; Hydrocyanic Acid; External Counterirritants, as Croton Oil, etc.; Diet and drink abounding in Carbon, as Codliver-oil, Alcohol; Hydrocarbons, as Gum, Starch, Sugar, Irish Moss, etc.
		investing	Sudden changes of temperature.	
		Membranes, Tubes, etc.	Cold applied to extremities, sending circulation to internal organ.	
	Circulatory System.	Heart and	Exercise.	Bleeding and Calomel, to diminish fibrin in blood in acute inflammation of lungs or membranes.
		its investing	Some vascular Tonics.	
		Membranes, its	Quinine, Dogwood, Willow, etc.	Antimony, Vegetable Acids, Saline Purgatives, Creosote; Pressure on Arteries; Rest, absence of excitement.
		Blood-vessels, etc.	Nitrogenized food.	Veratrum Viride. Non-nitrogenized food.
		Lymphatic System.	Mercury, Arsenic, Iodine.	Digitalis, Tobacco.
Abdominal.	Nutritive System.	Œsophagus; Stomach.	Emetics: Antimony, Ipecacuanha, Euphorbium.	Demulcents, Gum Arabic, Iced water, Gallic and Tannic Acids; Slippery Elm, Flaxseed, Irish Moss, Iceland Moss, Liquorice, Barley, Sago, Tapioca, Turpentine, Arrow-root.
		Pylorus.	Acetic Acid, Pepsin.	
		Liver, Pancreas, Spleen.	Calomel, Nitro-muriatic Acid; some Tonics, as Iron, Quassia, Columbo.	
		Mesentery, Omentum, etc., etc.	Purgatives: Rhubarb, Aloes, Jalap, Croton Oil; also, Aromatics: Pepper, Ginger, etc.	Astringents; Cold, etc.; Opium, Camphor, Spiced Syrup of Rhubarb.
		Small and Large Intestines, etc.	Electricity, to increase vitality, etc.	
	Reproductive Syst.	Urinary Organs,	Diuretics: Uva Ursi, Digitalis, Nitre, Buchu, Juniper, etc.	Nitrate of Silver.
			Indian Hemp, Hellebore, Turpentine.	Alkalies to dissolve calculi. Copaiba, Cubebs.
		etc., etc.	Aphrodisiacs: Phosphorus, Cantharides, Coffee, Heat, as by lying on feather beds.	Absence of mental excitement; Cold; Hard Beds.
		Uterus, etc.	Ergot, Aloes, and other Emmenagogues.	Cold, Sugar of Lead.
Tegumentary and Locomotive.		Bones.	Calomel, Corrosive Sublimate, (promote sloughing.)	Chlorine, Tincture of Iodine, Tannic Acid.
		Limbs.	Heat and Electricity, (in fœtal state especially.)	The absence or deficiency of these agents, during the period of gestation.
		Skin.	Heat, Ammonia, Cantharides, Belladonna, etc.	Cold, Colodion, Oils, etc.
		Hair.	Lac Sulphur.	Mental emotion, suppressed exhalations.
		Teeth.	Food abounding in phosphates	Creosote.

We think proof has been amply furnished that an excess of material, retained in any given portion of the system, is the most fertile source of disease; although sometimes a pathological state of the system may arise from a deficiency, which often results from excess in another portion.

This excess of material, in any organ, may arise from several causes. There may be too great an original mobility or irritability of that organ, (hereditary predisposition,) or there may be too much of some material furnished in nutrition, (errors in quantity or quality of diet,) or there may be a want of power in the eliminating organs, namely, in part of the absorbent system.

As additional proof of this, we need but remember the fact, that diseases of various kinds, even epilepsy and insanity, have been produced by the closing of an old ulcer, nature's excretory passage for an injurious abnormal excess of some material.

If disease, then, arise from excess of material in an organ, furnished or retained, we must next show that this excess exists usually more in given organs, (say the cephalic and thoracic,) in certain northern countries of comparatively early geological formation, while excess of material is more common in other organs—the nutritive and reproductive—in more southern countries of later geological formation.

To institute this comparison most favorably, we ought to have statistical tables of the number of cases of disease in a high northern latitude, say Silurian, where the habits were somewhat similar to those of a nation living in a Post-Tertiary formation, a table of whose diseases should also be equally carefully furnished.

In default of such facilities, we must content ourselves with, and perhaps may draw useful practical inferences from, a comparison made between the number of *deaths* from disease in several Northern States of our Union, and the number of deaths resulting from the same diseases in several Southern States, making use of the Mortality Statistics, derived from the Census* in the United States for the year 1850. I have rejected the column giving the total deaths, and have taken only that one including persons born in the State; because otherwise predisposing causes, brought from the mother country, might vitiate the inferences drawn from these results.

The States were selected without reference to any thing else than

* Carefully compiled by the accurate and learned Prof. DeBow.

the facility of equalizing the aggregate population in any given two; at the same time having them geographically as far apart as possible.

Some allowance ought to be made for various local circumstances, but even without it, tolerably fair general inferences can be drawn. By thus comparing the diseases of inhabitants in the extreme northern with those in the extreme southern United States, we think it will be readily seen that the relative proportion of cerebral, and other diseases of the organs of the head, are more frequent in northern latitudes than in southern; also that, in the latter, diseases of the abdominal viscera are more frequent; while abnormal action of the heart and lungs is found to be most abundant in middle latitudes.

In these tabulated comparisons, I have placed Alabama and New Hampshire in juxtaposition; New York and Louisiana, Mississippi and Vermont, and, finally, Massachusetts and Tennessee, without ony other choice in selection, as already remarked, than the distances apart and facility of multiplying the aggregate population in one State, as well as the diseases, in order to show at a glance the preponderance in either. For the last two compared, the population in each State was so nearly alike as to render any multiplication or other modification unnecessary.

COMPARISON OF MORTALITY FROM DISEASES IN NORTHERN AND SOUTHERN STATES.

ORGANS.	DISEASES.	NEW HAMPSHIRE.*	ALABAMA.
Cephalic	Apoplexy	56	18
	Brain	35	17
	Brain Fever	70	52
	Head†		10
	Paralysis	165	12
	Insanity	18	8
	Suicide	53	1
Thoracic	Consumption	766	109
	Lungs†		18
	Pneumonia	221	340
	Pleurisy	11	26
	Heart	165	16

* The aggregate population of New Hampshire being, then, 317,976, we multiply by 2⅜, making 748,610; near enough for practical purposes to the aggregate population of Alabama, 771,623. The number of deaths from any disease, in New Hampshire, was consequently also multiplied by 2⅜ before being transferred to the above column.

† In several cases, these statistics do not give a disease named in a previous column, perhaps having, in that State, included the disease under some other title:

COMPARISON OF MORTALITY, ETC.—CONTINUED.

ORGANS.	DISEASES.	NEW HAMPSHIRE.	ALABAMA.
Abdominal	Bilious Fever	30	73
	Jaundice	9	11
	Dysentery	1186	224
	Kidneys	3	4

The proportion of head and lung diseases is striking; but let us compare several others, to be more certain of our results, and of the consequent inferences.

COMPARISON OF MORTALITY FROM DISEASES IN NEW YORK AND LOUISIANA.*

ORGANS.	DISEASES.	NEW YORK.	LOUISIANA.
Cephalic	Apoplexy	184	200
	Brain	93	48
	Brain Fever	366	312
	Paralysis	235	42
	Insanity	39	18
	Suicide	51	18
Thoracic	Consumption	4531	1332
	Pneumonia	1139	834
	Pleurisy	78	384
	Heart.		
Abdominal	Bilious Fever	249	192
	Jaundice	46	30
	Dysentery	2991	546
	Bowels	171	84
	Kidneys	28	90

The above result, as regards bilious fever and dysentery, presents an unexpected anomaly; which may, perhaps, be partially accounted for by the imprudence of those residing in large cities: the city of New Orleans (excluding the transient residents) having a much smaller number of citizens than the city of New York. We all know that bilious fever and dysentery are more common and more fatal in warm climates than in cold. Asiatic cholera, although originating in the South, as it involves both gastric and intestinal organs, seems very fatal, irrespective of latitude.

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thus, diseases of *head*, mentioned in statistics of Alabama, may, in New Hampshire, be included under diseases of *brain;* so also diseases of *lungs* in Alabama may, in New Hampshire, be classed under the head of *pneumonia*, or perhaps of *consumption*.

* The aggregate population and diseases in the latter State have been multiplied by six, in order to place the comparison on equal bases: the population of the former State was, in 1850, 3,097,394; of the latter State, 517,762.

COMPARISON OF MORTALITY FROM DISEASES IN MISSISSIPPI AND VERMONT.

ORGANS.	DISEASES.	VERMONT.*		MISSISSIPPI.†	
Cephalic	Apoplexy	11		12	
	Brain	3	25	12	137
	Brain Fever	7		13	
	Inflammation of Brain	15		112	
	Paralysis	0		6	
	Insanity	1		3	
	Suicide	3		0	
Thoracic	Consumption	277		120	
	Lungs	3		7	
	Pneumonia	33		295	
	Pleurisy	8		20	
	Heart	19		19	
Abdominal	Bilious Fever	8		44	
	Jaundice	1		8	
	Liver	5		18	
	Inflammation of Stomach	2		98	
	" Bowels	9	14	0	
	Bowels‡	5		64	

Nearly the same general result is obtained, only Vermont seems less to dispose to diseases of the nerves than other Northern States, for instance, its neighbor, New Hampshire.

As the population of Massachusetts and that of Tennessee are about equal, I shall conclude these comparisons—which can be extended at pleasure by consulting the Mortality Statistics of the Seventh Census of the United States, or similar statistical tables in Europe—by placing the two States named above in juxtaposition.

COMPARISON OF MORTALITY FROM DISEASES IN MASSACHUSETTS AND TENNESSEE.

ORGANS.	DISEASES.	MASSACHUSETTS.		TENNESSEE.	
Cephalic	Apoplexy	64		27	
	Brain	252	391	0	238
	Inflammation of Brain	18		218	
	Brain Fever	121		20	
	Paralysis	198		27	
	Insanity	40		1	

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* Aggregate population, in 1850, was 314,120.

† Aggregate population, in 1850, was 606,526: consequently we divide disease by 2, disregarding fractional portions.

‡ I suppose this refers to diseases of the bowels not connected with an inflammatory state of the organs.

COMPARISON OF MORTALITY, ETC.—Continued.

Organs.	Diseases.	Massachusetts.	Tennessee.
Thoracic	Consumption	2548	603
	Lungs	175	1
	Pneumonia	475	296
	Pleurisy	87	49
	Heart	258	23
Abdominal	Bilious Fever	61	64
	Jaundice	10	11
	Liver	64	44
	Dysentery	2091	154
	Inflammation of Bowels	117	89
	Bowels	364	10

Here we have, again, some anomalies: due partly, no doubt, to the fact of Massachusetts having so many more large cities. Still, as a whole, Tennessee, probably from her central position, seems less subject to fatal diseases, even of a southern type.

I have had very few facilities for applying these tests to diseases or to mortality from disease in Europe. Dr. Paul F. Eve, of our University, so celebrated for his acquirements as a surgeon, informs me that, by reference to Lawrence's Monograph on Hernia, he finds double the per centage of cases in southern Europe, compared with those in northern; he also tells me that aneurisms and cardiac diseases are much more common among the inhabitants of Great Britain than those of the United States, and that, while the urinary calculi in the former country are chiefly of uric acid or urate of ammonia, the calculi he has usually operated upon in the South are composed of oxalate of lime.

The great prevalence of pulmonary consumption among the inhabitants of Great Britain is too well known to require comment; and there it sometimes occurs, in spite of judicious exercise, moderate exposure, and rational clothing. This disease is by no means uncommon among the Chippeway and other North American Indians, as I found, much to my astonishment. Its prevalence was confirmed by the testimony of Dr. J. G. Norwood, now State Geologist of Illinois, whom I accompanied in an exploration of Lake Superior's north shore, undertaken as a branch of the survey of Wisconsin, Iowa, and Minnesota, by my brother, Dr. David Dale Owen, then United States Geologist, now engaged by Kentucky to examine and report upon her mineral wealth. Dr. Norwood, having conducted explorations for several years among these In-

dians, and having previously been a highly successful practitioner of medicine in the city of Madison, Indiana, was eminently qualified to give testimony on this subject.

A gentleman of observation, some years engaged in an Italian navy-yard, and who had extended means of observation, informs me that over four-fifths of the workmen there were more or less affected with gonorrhœal or syphilitic diseases,* which he, however, states readily yield to treatment. The prevalence of these in some southern countries, and the Jewish tendency to extraneous prepuce, may have given rise to the necessary sanitary enactment of circumcision.†

That leprosy, elephantiasis, frambœsia,‡ and most other skin diseases prevail in the Tertiary countries more than in the Palæozoic, must, I think, be evident to all.

It is stated, but I have not examined whether the evidence is sufficiently corroborated, that in China six fingers and toes are by no means uncommon.§

I might go on to an indefinite length, citing various facts, apparently confirmatory of the assertion, that some diseases are peculiar to or more prevalent in certain geological formations than others; and that, generally speaking, more tendency to diseases of the organs in the head and thorax will be found to prevail in Secondary formations, while diseases of the nutritive and reproductive organs predominate in the Tertiary and Post-Tertiary. But I shall reserve a good many details for the Appendix, and here only ask permission to discuss, shortly, some causes contributing to a few important diseases, followed by an indication of the probable remedies: a discussion which might as appropriately, however, have been placed in the next chapter. Consumption, being one of our greatest scourges, may be selected first.

The use of a simile may mislead occasionally, but as the phenomena

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* They are also prevalent in Fezzan, Africa, but said to be also easily cured. See Encyc. Brit., vol. i., p. 260.

† Common also among the negroes. Ibid, p. 268.

‡ Exceedingly common in Africa. Ibid, vol. xiii., p. 434.

§ The few cases of a similar abnormal *repetition* of organs that have fallen under my own observation were in Secondary countries, bordering on Tertiary: the same, however, applies, rather unexpectedly, to the cases of *deficient* limbs with which I am personally acquainted, as they also were in late Secondary formations.

of respiration and the combustion of fuel are admitted to be similar chemical action, I may be permitted to extend the comparison. A fire may fail to serve the end designed, from three causes: 1. From a want of pure carbonaceous matter to combine with the oxygen of the atmosphere, there may be *imperfect* combustion. 2. From too great a supply of oxygen, there may be so *rapid* a combustion as to exceed the rate of carbonaceous supply. 3. From a deficiency in the amount of pure oxygen necessary to keep up chemical action, there may be feeble combustion. So it is in respiration: From a want of carbon in the materials used, the blood in the lungs may not present a sufficient amount to unite with the oxygen inhaled, and consequently the tissues themselves become oxidized, as in consumption; or, if the amount of oxygen inhaled, from some cause,—too much condensed cold air, too much excitement, or violent exercise, etc.,—is more than adequate to consume the carbonaceous matter which we can readily assimilate, then we shall have pulmonary consumption, also; or there is an insufficient supply of pure oxygen, giving rise to asphyxia, suffocation, extinction of animal respiratory combustion.

In the first two cases, what is the remedy? Either to increase the amount of carbon, by a proper selection of diet—not, I should suppose, by the use of large quantities of nitrogenized animal food, but, if the stomach will bear it, by that of carbonaceous animal fats, oils, butter, milk, also chocolate, farinaceous diet, etc., etc.; or, on the other hand, to diminish the amount of oxygen, by removal to a warm climate, where, the volume of air being greater, less oxygen is inhaled at each inspiration. Should this be impracticable, artificial means might be resorted to for diminishing the amount. If, however, a quantity of waste matter is formed, notwithstanding all efforts, it is at least well that it should be eliminated by expectoration.*

It has also been observed that the scrofulous matter leading to consumption abounds largely in albumen: indeed, some suppose scrofula to be retained effete matter. Can the albuminous matter

* The night-sweats and the bleeding from the lungs (hæmoptysis) seem to be efforts of nature to relieve an overcharged organ, in the former case by vicarious action, in the latter by direct depletion.

arise from the excess of nitrogen, which the laboring organ is unable to expel?

We next turn our attention to those diseases in which the blood, from arriving in a depraved state in the region of the brain, makes painful, false, or injurious impressions: varying through the phases of indigestion, dreams, somnambulism, fever, the seeing of objects not present, hydrophobia, delirium, insanity, etc. Here again I ask permission to make a comparison, which I hope will not lead to error. When to certain vegetable substances a sufficient amount of yeast or ferment—an organized development of albuminous fungous globules*—is added, the whole mass undergoes a similar change or decomposition. Can it be that when a rattlesnake or a rabid animal throws poison into the blood, or when indigestion generates abnormal materials, when fever produces too much fibrin or decomposable, putrescent matter, etc., etc., there is added to the blood too much material capable of ready fermentation and decomposition, disturbing more or less the normal action of the brain, which can only maintain its healthy function under a healthy stimulus?

Having thus briefly hinted at some of the immediate causes of disease, I pass on to examine whether any general law governs their progress, when they become endemical and epidemical.

It has been frequently observed, that many of our great epidemics came from the East,—some from the East Indies, some from Syria, perhaps,—and that the progress is in a westerly or north-westerly direction. Thus, the plague travelled from Asia Minor to London; the cholera, from India to Petersburg, thence to Great Britain, then across the ocean both to the Atlantic States of America and to the Gulf of Mexico. The line thus far is chiefly along the junction of the Tertiary and Secondary. Some diseases originate in certain localities without any apparent cause. Does it not seem probable that what we term miasmata, malaria, etc., supposing them to originate under the earth's crust, should emanate from the soil more readily in the region of a geological outcropping, where rock-edges and intercalated porous materials come to the surface, than in the centre of a curved anticlinal axis or middle of a great unbroken deposition, especially of rock material? Regarding this subject, I can bring forward so few facts, that I merely mention it

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* Silliman's Chemistry, pp. 404 and 516.

for consideration. Diseases have been observed to follow water-courses; but whether that arises from the aqueous vapor* transmitting the miasmata, or from these lowest river-beds being often synclinal junctions of disturbed strata, would require more data than I can offer to determine the question.

Some general remarks on

THERAPEUTICS,

or the Remedial Agents to be employed in the cure of disease, will, in accordance with the heading, be required before closing this chapter.

Not professing to have the experience of a regularly-established practitioner,—although I have enjoyed advantages for observation, while aiding the various surgeons† who have attended our students,—I yet venture the prediction that, as the all-important science of medicine advances, it will be directed more to the giving of judicious advice regarding prophylactics, or preventive remedies, and to the hygienic injunctions which would save many a valuable life, by avoiding predisposing causes, than simply to the administration of remedial doses, however strictly prescribed in accordance with the rules of the pharmacopœia, or the dictates of experience. The best physicians declare that a small amount of prevention is better than a large amount of curative means; and particularly that we must live in obedience to the laws which enlightened practitioners have traced out as being in accordance with nature. We should therefore be more anxious to secure from such men their advice than to demand of them a bolus.

As, however, this subject belongs more strictly to the next chapter, I shall close, by remarking that, by looking over the imperfect tabular view of remedial agents, at pages 138 and 139, which only professes to give a few of the most prominent, and by consulting works on physical geography, when we fail to remember

* Dr. Ure, in his lectures, was in the habit of remarking that hydrogen was probably a vehicle for the transportation of infection, as chlorine, probably by its immediate union with it, proved so powerful a disinfecting agent.

† In this connection, without invidious distinction, I may perhaps be permitted to mention gratefully the valuable advice I have received from Dr. Mulloy, of Robertson county, Tennessee, and from Dr. Bowling, the widely-known Professor of Theory and Practice in the Nashville Medical College.

in what countries these agents are found, we cannot fail to perceive that, generally speaking, the remedies for diseases of the alimentary canal are to be found in those regions where such diseases prevail. Thus, opium and camphor are produced where cholera abounds; salts and opium, where dysentery is prevalent. Mercury is plentiful where excessive fibrin in the blood produces febrile action; rhubarb and aloes are abundant where the bowels are most liable to be affected. Or, again: codliver oil is obtained best, and mucilaginous as well as farinaceous plants grow most abundantly, in those regions where pulmonary diseases indicate the exhibition of such therapeutic agents.

Occasionally, doubtless, where disease arises from the too prevalent introduction into the system of some indigenous material, the remedy would consist in employing diet or medicine of a contrary tendency, probably most abundantly found in other regions: hence the great benefit of commercial intercourse, in procuring the proper agents; the vital importance of diagnosis, in detecting the material wanting, or in excess; and the indispensable aid of chemistry in proving the presence or absence of a desired material in a prescribed article of diet or medicine.

In the next chapter it is proposed to close, after a short review, by placing such inferences as the above more prominently before the reader.

CHAPTER VIII.

Ethical Geology: Summary and Correlative Inferences, presenting some practical suggestions, deduced from the foregoing laws, as to the most effective means of improving the physical, mental, and moral condition of the Human Race.

HAVING, in the previous chapters, endeavored to exhibit briefly, yet somewhat in detail, such facts as occurred to me regarding the subjects there discussed, and feeling that those ideas were often presented with abrupt transitions, and in very disconnected form, the design, in this chapter, is to condense the whole, and attempt to present the data and inferences in a more consecutive and systematic form.

Commencing with the collated data according to the order of the chapters, we may comprise them in the following

SUMMARY;

which, it is hoped, in connection with the large *Tabular Synopsis*, or *Diagram VI.*, will serve to make the attempted generalization or systematic comparison as intelligible as can at present be expected;* until extended time and observation have aided, either in rendering the whole so plain and full of truth-evidences that few,

* Even during the short period devoted to writing this essay, as the work progressed, I saw some facts more clearly working themselves into the generalization than was at first apparent. Occasionally, therefore, as might naturally be expected, I have had somewhat to modify details, although never to alter the fundamental principles of generalization. When any such discrepancies or conflicts are visible, the statements in the latter part of the work claim to be corrections of the former inadvertencies, which, as the sheets were printed off daily, as rapidly as written, could not be altered in the press, without involving a reprint of very considerable portions, but are noted in the enumeration of Corrigenda.

if any, will doubt; or in offering such a collection of more abundant antagonistic facts as will conclusively prove the supposed generalization to embrace a *minority* of facts, and consequently to be only a systematic arrangement of *exceptions* to the general laws governing the universe.

In the *first* chapter the object was to show that there was, when carefully examined, a remarkable uniformity in the *measurements* along and across large bodies of *land*, as well as of *water;* that smaller distances were measured by subdivisions of the same, showing a remarkable uniformity of laws in producing these separations. In measuring these distances we must not *count* the *number* of degrees, but take the actual measurement from the equator on to the unelastic material, which we then apply to any other portion of the globe in making our estimates.

Thus *measured*, not *counted*, many of the most important distances, as the greatest length and width of Africa, and the length either of North or of South America, as well as the extreme elongation of Asia, from the North-east Cape to Cape Comorin, are found to extend 66½ degrees: the complement of 23½,* that change which the earth's axis is supposed to have undergone relatively to the plane of its orbit, while this separation of parts of the earth's crust was taking place.

At the same time, the *direction* given to these gradually emerging plastic portions of the crust was, north of the Tropic of Cancer, frequently parallel to the old axis, consequently forming an angle of 23½ degrees with the present axis of the earth. In intertropical regions the variation from the north and south axis is often 66½ degrees, consequently 23½ degrees from the equatorial plane, and consequently also coincident with our ecliptic;† of course, therefore, coincident with the plane of the earth's path round the sun.

South of the Tropic of Capricorn, the terminal form of continents and islands has assumed usually a north and south direction. The greatest elongation of land over the entire globe is, however, to be found along a plane, *not* at right angles to the present plane

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* Exact calculations (see Mrs. Somerville's Physical Geography, p. 16) make the inclination of the earth's axis to the plane of the ecliptic 23° 27′ 34.69″; but for practical geological estimates, we may be permitted, temporarily, to disregard the smaller fractional numbers.

† When the axial plane coincides with N^{I}, X^{I}, N^{II}, on Map 1.

of diurnal revolution, but *at right angles to the plane of the earth's orbital progression.** The contest, therefore, seems to have been exerted between forces acting, in one case, at right angles to the axial plane of *diurnal* motion; in the other, at right angles to the axial plane of *annual orbital* progression,† thus separating the land frequently into spherical surfaces which, if planes, would be rhombs.

Many of the most important *Mountain Ranges* partake of the above directions indicated for continents; while minor ranges frequently converge towards the highest point on each continent, as to the Alps in Europe, to the Himalaya Range in Asia, towards the equatorial Andes in South America.

The *Rivers* in the earlier geological formations—as the Rhine, Rhone, Danube, etc., in Europe; also several in Asia, and the Mississippi, Mackenzie, and St. Lawrence Rivers, in North America—diverge north, south, etc., from about latitude 45° N.; whereas the yet larger rivers, of later geological formations, such as the Nile, the Niger, the Amazon, and the La Plata, take their origin not far from the line of the ecliptic, where we might naturally expect to find the height of land.

The various *dislocations*,‡ greatest caverns, etc., often found where limestone strata have been elevated, seem to exist underneath the region where the alternate expansions and contractions of the earth's crust, in a north and south direction, chiefly took place: namely, along the Alpine Median Line and American Median Line, or Great Circle of the Earth. These caves, subterranean rivers, submarine whirlpools, caverns, etc., may be regarded as the type of the cavities left in organic bodies by absorption and consolidation of certain formative materials. The greatest general

* In connection with this subject, read the lucid and fascinating exposition of the laws governing the solar system, as given by Prof. Mitchell, of Cincinnati, in his work entitled, "Planetary and Stellar Worlds." See especially page 152.

† In other words, the conflict was between equatorial or terrestrial force (the analogue of carpellary inter-dissepimental expansion) and ecliptic or electric or magnetic force, (the analogue of the germinal growth, expansion, or development.)

‡ Some of these dislocations or displacements of strata, technically termed by miners "Faults," exhibit evidences of very considerable disruptive power. Several of the most important in the great English coal-mines (as mentioned in "Trimmer's Practical Geology and Mineralogy," Lea & Blanchard, Philad., 1842, pages 239, 244, etc.) seem to correspond with the line K, M, on Map 1, alluded to especially near the close of Chapter VI.

depression of land, it is supposed, will be found near these dissepimental junctions, X^{I}, X^{II}, X^{III}, X^{IV}, and Y^{I}, Y^{II}, Y^{III}, Y^{IV}; while the greatest general elevation of land will be intermediate between the above-named great circles of the earth, or possibly *vice versa.*

Regarding the greater relative age and density of the geological formations in the northern portions of the globe, it is, perhaps, unnecessary to say much.

I will, therefore, only again remind the reader of its being admitted, that any or all of the strata forming the earth's crust may be brought—in the inverse order of their consolidation or deposition—to the surface; but that the expansive forces from within have acted in such a manner as to bring, especially in the northern hemisphere, the strata to the surface in concentric spherical triangles; and further, that the space enclosed between the large and intermediate triangles consists chiefly of late geological formations, whereas the interior smallest triangle encloses Ancient Hypogene Rocks, and has one of its angles at M, near the Malström, where the centre of rupture, and of consequent boulder dispersion, seems to have existed.

With reference to the distribution of Minerals, particularly Metals, I think nothing can be more evident, than that we may expect to find certain metallic ores most abundantly not far from the lines of these spherical triangles where different strata unite; especially, however, near the junction of the Metamorphic and Secondary Rocks, or near the junction of the Secondary and Tertiary Rocks.

Thus, *copper* has been found abundantly along the lines B^{I}, B^{II}, etc., as well as near the lines C^{I}, C^{II}, etc., as indicated on Map 2; and we might most reasonably expect to find it hereafter in places near the same continuous lines. Coal we might expect to obtain in greatest quantity from countries situated between those two lines, probably somewhat nearer to C^{I}, C^{II}, etc., than to B^{I}, B^{II}, etc. Coal may, however, be met with, usually of a somewhat different character, in periods anterior, as well as posterior, to the true coal-period now indicated. Near the same beds above mentioned are very frequently to be found the lead, zinc, and other rarer metallic ores. Silver is also obtained in this same range, and even quicksilver, platina, and gold; but silver is probably more abundant in the Tertiary, while gold and quicksilver are in a still later forma-

tion. If Australia ever occupied the position assigned to it in Diagram I., then nearly all the most productive gold-washings and auriferous quartz will be found on a great circle, indicated on Map 1 by the letters N^{I}, X^{I}, N^{II}, and already mentioned as having near it some of the most remarkable volcanoes, of almost monthly activity. This great circle forms the axial plane of our ecliptic when that orbital plane decussates the equatorial at O and P, on Map 1.

Most of the salts, the thermal springs, and the bituminous products of the coal, will be found not far from the great line of coal-fields above indicated. Somewhat farther south we find the gypsums, the fine clays impregnated with different colors from various metallic oxides, as well as also the masses of porous limestone under the denominations of tufa, travertino, etc.,

The siliceous minerals of the quartz family are not unfrequent in late Secondary formations, whereas the precious aluminous gems are found chiefly in the Tertiary and Quaternary periods.

Iron, as indicated by an enumeration of its best localities, although fortunately abounding over the globe, is found of the best quality near the dissepimental great circles X^{I}, X^{II}, X^{III}, X^{IV}, and Y^{I}, Y^{II}, Y^{III}, Y^{IV}, especially in their northern portions.

An attempt was made, in closing Chapter I., to point out a similarity between Asia and Australia, when compared with Europe and Africa, or when compared with North and South America; showing that, if the continents separated in the manner suggested, the development bore analogy to the earliest or lowest forms of reproduction in the organic world.

Not desiring to dwell too long upon this synoptical review, I now proceed to examine the means which it appears were brought to bear in producing these various terrestrial changes. The subject is discussed somewhat in detail in the *second* chapter, and there now only remains the necessity for a brief review, to enable the reader to decide regarding the probabilities of the suggestions.

Our planet is imagined to have been, "in its original chaotic condition,* like the matter of all suns and worlds, and, like the matter composing the tails of comets, *nebulous*. Under the laws of gravitation, this nebulous fluid, scattered throughout all space, commences to condense towards certain centres. The particles

* Mitchell's Planetary and Stellar Worlds, p. 246.

moving towards these central points, not meeting with equal velocities, and in opposite directions, a motion of rotation is generated in the entire fluid mass, which, in figure, approximates the spherical form. . . . As the globe gradually contracts, its velocity of rotation continually increasing, another ring of matter may be thrown off, and another planet formed; and so on, until the cohesion of the particles of the central mass may finally be able to resist any further change, and the process ceases. The planetary masses, while in the act of cooling and condensing, may produce satellites in the same manner, and by the operation of the same laws by which they were themselves formed."

The gaseous materials, as they consolidated from the above nebulous extension, arranged themselves, in a great measure, according to chemical affinity, dependent, doubtless, upon the fact that some of them were in an electro-negative state, while others were electro-positive, modified by their proximity to each other. The chief products of early periods were metallic bases,—such as potash, soda, lime, magnesia, oxide of iron and of manganese, silica, alumina, etc.,—formed by the union of the metals with that abundant and all-pervading gaseous body, oxygen. At a later period were found the acids, furnishing, by their union with these bases, the numerous salts of the Secondary period: the acids themselves being found occasionally, in the last periods, even pure and uncombined.

When these various materials consolidated, they obeyed also the same geometrical laws which we now observe governing the mineral world. Around a central nucleus the solidifying particles arranged themselves, forming regular crystals, (frequently cubical, sometimes the more elongated prism-solid,) such as those of quartz or felspar, the former when silex alone was abundant, the latter when alumina was added; or hornblende, when some magnesia and manganese were present. These and other similarly-formed materials aggregated into rocks, while some of the cementing materials were yet plastic, and were finally consolidated into our granites, syenites, greenstones, etc., of Ancient Hypogene date, by pressure and by electrical agency.

After these materials had cooled sufficiently to permit the united oxygen and hydrogen to condense into rain, this agent, partly by its mechanical effects and partly by its chemical, solvent power, reconverted portions of these hard rocks into detritus, which, wash-

ing from the higher portions of the globe,—aided, too, by the tendency loose materials would have to fly from that portion of the spheroid where there was less motion to another where there was greater,—accumulated in intertropical regions, to be converted by pressure and electricity into the less dense, stratified rocks, enclosing within their loose, yet gradually consolidating, materials the remains of such vegetables and animals as had been previously able to sustain existence under these peculiar circumstances.

Meantime internal electrical forces, resulting remotely from the sun, but probably immediately from chemical action or from difference in temperature of materials, and also the expansive force of the solid bodies thus reconverted into liquids, vapors, and gases, all acting on the earth's crust, especially those portions which were yet in a plastic state, caused these to expand and to separate.

This expansion, at first, was exerted along planes coincident with our present axis of diurnal revolution, and gradually became transferred to the axis of orbital annual progression, or, we may say, to the magnetic axis; for the magnetic equator nearly coincides with one position of our ecliptic, namely, when the latter decussates the plane of the terrestrial equator at the points on Map 1 marked O, P. Half-way between those two points is R, the central point of magnetic vibrations resulting from electrical currents. M is the centre of dispersion and separation, being equidistant from all points of the great circle N^{I}, X^{I}, N^{II}, along which plane the greatest amount of electrical, and consequently of volcanic, force is exerted at the present day, as evinced by almost monthly outbursts; and being one angular junction of hard crystalline, Hypogene, igneous rocks with the more yielding Secondary aqueous strata.

Having thus hurriedly glanced at some of the dynamical elements brought to bear in moulding the earth into its present form, our synoptical view must next pass to the examination of the numerous points of resemblance to be found between this mode of terrestrial development and that which may be observed by the botanist or agriculturist in vegetable germination; or by the comparative anatomist in zoölogical embryology; as well as later, in the full development of the plant or of the animal.

This generalization is often so intimately connected with the varying geographical peculiarities of the flora and fauna, as well

as of the different races of men and their diseases, that occasionally, no doubt, the details, ranging through Chapters III., IV., V., VI., and VII., may here be found blended, while the attempt is made to converge the facts and arguments to a focal centre of conviction.

If an individual, who has examined the earliest developments of the vegetable or animal germ, compares these with the earlier phases of the earth's development, he can scarcely fail to be struck by the resemblance.

The same great plan has been carried out in all three; similar objects have been effected by varying means, means which, however, bear a strong analogy.

In each there is a nucleus or centre of consolidation, around which materials are deposited from a formative fluid, contained within a consolidated covering of the same. That nucleus, in the mineral world, is the primary crystal or aggregation of primitive molecules, also the terrestrial nucleus of crystalline materials in the earth; in the vegetable world it is, to unaided vision, an ovule, containing numerous concentric nests of microscopic ovules or nuclei; and, in the animal world, it is also a minute ovum, containing a microscopic nucleus, and that again a nucleolus, and that also again a molecule, etc., *ad infinitum*. The formative fluid in the mineral crystal is the water of crystallization; in the terrestrial ovum, it is the molten, igneous rock-fluid; in the vegetable ovule, it is the pulpy mass or amnios, (see tabular comparison, on page 80;) in the zoölogical world, it is the fluid usually termed blood, that nourishes the animal after birth; in the embryo-investing amnion, it is the liquor amnii; in the ovum, it is the yolk; in the germinal vesicle, it is the clear watery fluid; again it is found, as the pellucid fluid around the nucleolus of the cytoblast, and, perhaps, as the albumen-coated fat or oil-drop around the granule, or molecule, the smallest atom of which our senses can appreciate the size.

The investing membrane in the mineral crystal, or in the earth's crust, is of the same materials as the formative fluid, rendered solid by cooling or by evaporation of their more fluid portions; the integuments of the vegetable ovule are the secundine and the primine; or, again, the integuments of the seed are found inclosing the nutritious albumen which surrounds the embryo; in the

animal world the investing membrane is sometimes a simple membrane, sometimes a membranous cell-wall; or, again, the envelope of the germinal vesicle, the membrane of an ovum, an epithelial tunic of a Graafian vesicle, the vitelline membrane which encloses the yolk of the bird's egg; or, in the mammalia, at a more advanced stage, it is also, probably, the amnion, which contains the embryo and its circumambient fluid.

In the yet later developments visible in the three kingdoms, we can still trace the analogy: in the animal, we have the formative fluid, blood, depositing its materials for growth and nourishment on the internal nucleus, now become, in the most perfect animals, bone, muscle, etc., as well as various products elaborated from it through glands, the whole enveloped in the various dermal integuments; we find, in the vegetable world, the formative sap-fluid depositing its solid materials on the nucleus, to increase the amount of woody fibre and the sap-products of secretion, all covered by a cortical investment; while, in the earth, we observe that the formative fluid, now water, deposits its various solid ingredients—held previously in mechanical mixture or in chemical solution—upon the original nucleiform materials, the crystalline rocks, the whole surrounded by, and enveloped in, the atmosphere.

Let us now consider the different modes in which the developing embryo communicates with, and receives nourishment from, the matrix, and see if the analogy still holds good.

Here permit me to remark how well aware I am that, as stated by Agassiz and Gould, in their Principles of Zoölogy, "It should chiefly be by the *homology*,* or affinity in the relation of organs constructed on the same plan, that we should be guided in the arrangement of animals, not by *analogies*, or similarities of functions;" but perhaps the latter may serve better for the purpose of comparing the three kingdoms, and noting how far a general law required to be modified, in order to give rise in each to the beautiful yet harmonious varieties, observable in the three kingdoms of Nature's peerless domain.

Beginning, this time, with the most perfect organization, I again avail myself of the lucid explanations of Drs. Kirke and Paget, as

* See page 6 of the above work.

well as of resources due to the untiring industry of the celebrated Dr. Wm. B. Carpenter,* Examiner in Physiology and Comparative Anatomy in the University of London.

"The parietes† of the body of the embryo are reflected upon themselves, as it were, so as to form the membrane of the amnion. The part at which the reflection takes place is the umbilicus."

"The deciduous membrane‡ is found, at a later period, to consist of two layers: the *Decidua vera* lining the uterus, and the *Decidua reflexa* covering the exterior of the ovum." . . . "When the ovum enters the uterus, it becomes partially imbedded in the substance of the decidua." . . . "The surface of the ovum, thus surrounded by the double layer of the deciduous membrane, is rendered shaggy by the growth of villous tufts from the surface of its investing chorion." . . . "In its earliest stage of development, the chorion and its villi contain no vessels; and the fluid, drawn in by the tufts, is communicated to the embryo, by the absorbing powers of the germinal membrane of the latter. But when the tufts are penetrated by blood-vessels, and their communication with the embryo becomes more direct, the means by which they communicate with the parent are found to be still essentially the same; namely, a double layer of nucleated cells, one layer belonging to the fœtal tuft, and the other to the vascular maternal surface. It is from these elements that the *placenta* is formed."

"The first stage in this process consists in the extension of the fœtal vessels into the villi of the chorion over its entire surface." . . . "On looking at the fœtal surface of the human placenta, we perceive that the umbilical vessels diverge in every direction from the point at which they enter it; and their subdivisions form a large mass of capillaries, arranged in a peculiar manner, and constituting what are known as the *fœtal villi*. Each villus contains one or more capillary loops, communicating with an artery on one side and a vein on the other; but the same capillary may pass into several villi, before reëntering a larger vessel. The capillaries of the villi are covered, as in the chorion, by a layer of cells, enclosed in basement membrane; but the fœtal tuft thus formed is enclosed

* Consult his Principles of Human Physiology, edited with additions by Dr. Francis Gurney Smith, edition of Blanchard & Lea, Philad., 1855, pp. 767, 768, and 769.

† Kirke and Paget, p. 500.

‡ Carpenter's Physiology, pp. 767, 768.

in a second series of envelopes, derived from the maternal portion of the placenta, a space being left, however, between the two, at the extremity of the tuft."

"Whilst the *fœtal* portion of the *placenta* is thus being generated by the extension of the vascular tufts of the chorion, the maternal portion is formed by the enlargement of the vessels of the decidua, between which they dip down. 'These vessels assume the character of sinuses; and at last swell out (so to speak) around and between the villi; so that finally the villi are completely bound-up or covered by the membrane, which constitutes the walls of the vessels, this membrane following the contour of all the villi, and even passing, to a certain extent, over the branches and stems of the tufts. Between this membrane or wall of the enlarged decidual vessels and the internal membrane of the villi, there still remains a layer of the cells of the decidua.' (Prof. Goodsir's Anatomical and Pathological Observations, page 60.) In this manner is formed the *maternal* portion of the placenta."

In the *vegetable world*, "the placenta* is that part of the ovary from which the ovules arise, and to which they are attached. It consists of a line or fleshy ridge placed in some angle of the cell. Its direction is always vertical, that is, parallel with the axis of growth. . . . The placentæ† are developed at each of the two edges of the carpellary leaf. If these edges be in their normal conditions, that is united, there will be apparently but one placenta to the carpel, and that central. . . . But the placentæ are sometimes found in the common centre, when there are no dissepiments. This anomaly, which is called a free central placenta, (see Diagram III., figs. 3 and 4,) is thus explained. The dissepiments were at first actually formed in the usual manner, but afterwards, by the rapid expansion of the shell, they were torn away and obliterated. As the ovules are always developed by the placentæ, they, of course, grow out of the margins of the carpellary leaf, and are, therefore, understood to be analogous to buds. . . . The stalk,‡ by which the ovule is connected to the placenta, is called the *funiculus*, and its point of attachment to the nucleus of the ovule, the *chalaza*. (See Diagram III., figs. 4 and 5.) Through these the ovule receives its nourishment from the placenta."

* Wood's Class-Book of Anatomy, p. 40. † Ibid, p. 43. ‡ Ibid, p. 44.

In the *Mineral Kingdom* we have seen cause to believe that there have been various alternations of expansion and contraction along two great circles (X^{I}, X^{II}, X^{III}, X^{IV}; Y^{I}, Y^{II}, Y^{III}, Y^{IV}, on Map 1) dividing the globe into four spherical wedges or ungulas, (see Definition on page 29,) with a primary tetrahedral nucleus resembling the free central placenta, which is supposed to communicate with the earth's crust more especially at the angular junctions and depressions, such as the region of the Malström, for the inner triangular upheaval, and Palestine, probably about the Dead Sea, and former sites of Sodom and Gomorrah, (see Diagram III., fig. 1,) for the junction of the Secondary and Tertiary triangular upheavals. As in the vegetable kingdom, it is near the junction of the carpellary leaves that we find the ovule developed by the placenta; so it appears that the earth's spore, which we have supposed to be the moon, was thrown off during some great convulsion of nature from the region of the Levant. Portions of Arabia, from which we suppose New Holland to have been removed about the same period, would represent the analogue of the maternal decidua, while New Guinea is the type of the umbilical vesicle, and Australia seems that of the rejected placenta: the foramen and chalaza, or type of the umbilical cavity, being in those formerly lava-emitting, bitumen-forming, arid depressions, thirteen hundred feet below the surface of the Mediterranean, near the supposed birthplace of many of the Mammalia, as well as near the cradle of the Human Race.

In the animal, this same reflected decidual layer of the maternal uterus (which partially covers the ovum, and, later, the chorion, with its reflected layer, the amnion, which envelops the embryo, coalescing by the growth of villous or vascular tufts to form the placenta, as just described above) is at a yet later period represented by the outer, upper, or serous layer of the chorion or vitelline membrane, which, forming the framework of the animal, whether skeleton, calcareous dissepiments, or mere spiculæ, is finally extended by fascia or other dissepimental communication with the exterior of the animal, and consolidates by evaporation of its more fluid parts into shell, shields, scales, horn, nails, skin, etc., thrown off occasionally by desquamation.

So also in the plant, these dissepiments, which separate the pericarp into cells, and which in the dicotyledonous tree emanate from the pulpy nucleus, the pith, and separate by its medullary rays the

gradually expanding and diverging cells, finally communicate with the exterior, and form bark, portions of which are annually shed.

In the terrestrial sphere, we find the fluid, molten materials of the central mass coming to the surface and forming, by their consolidation, first the early hypogene, crystalline, backbone-framework of the earth's crust, then the more recent plutonic rocks as well as early volcanic basaltic columns and dikes of submarine outbursts; and, lastly, the extinct and recent trachytes and lavas of modern outflow, spreading over the surface, and hardening by age into new vesicular rocks, to be again worn down and shed off by the disintegrating action of water and air.

These nucleo-cell-wall intercommunications, these interno-external dissepimental envelopes, or endo-exo-framework formations in the animal and vegetable world, whether as animal bone, skin, or shell, as seed-skin, nut-shell, or fruit-skin, are not, when taken into the animal stomach, suited for digestion or assimilation, and are therefore rejected but little altered; so, in the mineral world, the silex and alumina constituting largely the early crystalline rocks, even when disintegrated by aqueous and atmospheric agency, and re-deposited in loose layers,* contribute very little to the nourishment of the plant. If the serous layer in the animal ovum, as usually supposed, forms also the muscular tissue, then it gives rise, we must admit, to a part which is nutritious, but could it be so without the important products from the formative fluid, of the vascular layer?

* The abrasion of the siliceous rocks has, I think, already been alluded to as resembling the gradual peeling off of the rough external bark, or the desquamation of scales or of the cuticle, the shedding of feathers, teeth, horns, and other dermal appendages.

This would apply to all these products of the skin, although we remember, as stated by Agassiz and Gould, page 99, that the skin consists of three layers, (the *leather*, the *vascular layer*, and the *epidermis*,) and that "the scales of reptiles, the nails of mammals, and the solid envelopes of the crustacea are merely indurated products of the epidermis. On the other hand, the feathers of birds and the scales of fishes belong to the vascular layer."

In this connection, although rather irrelevant to the discussion, I ask permission to make the suggestion that as manufactured leather is a *Tannate of Gelatin*, it is not impossible we might, when the increased scarcity of hides compels us to devise some new means, imitate the felted cloth, by manufacturing leather, suitable perhaps for belting, if not for shoes, by forcibly compressing the tannate of gelatin, obtained from duly proportioned mixtures of glue and tannin, adding, if necessary, gum-shellac, or other water-proof material.

Or could that again continue to keep up a supply, if not renewed by the nutritious materials imbibed through the mucous layer?

In the same manner, the inorganic soil becomes an important mechanical aid to retain or transmit the saline and other products nourishing the plant.

Interesting and extensive as this subject readily shows itself to be, it is perhaps inconsistent with the plan of a merely suggestive Essay, which this professes to be, to dwell much longer on details. I therefore proceed to glance rapidly at the additional subjects of comparison.

The skeleton in the Mammalia has for its animal portion, gelatin; the blood and the muscles are chiefly albuminous; and the skin again contains large portions of gelatin. What is the chemical difference between gelatin and albumen? The amount of oxygen and nitrogen is much greater in the latter than in the former; besides the addition of small quantities of sulphur and phosphorus in albumen. Has the nitrogen gone to form fibrin; have the oxygen and phosphorus united to deposit the earthy matter of the bone, increasing in old age; has some phosphorus been consumed in supplying the brain, and is the sulphur to be accounted for chiefly in the hair and nails? Is it thus that albuminous material may be converted into gelatinous tissues? These questions can best be answered by a Liebig.

In the vegetable kingdom, the carbon is found in the woody fibre, cellulose being identical in composition with starch; the cotyledons of seeds contain nitrogen in abundance; gluten is vegetable fibrin, while legumin is more like the casein in milk. The nitrogen then is most abundantly supplied by absorption of ammonia from the atmosphere at the period when most required, the perfecting of the seed.

In the mineral world we have chiefly the bases forming the earlier and more solid portions of the earth; later, we have carbon deposited from the formative fluid water, elaborated through the medium of the vegetable world from the carbonic acid of the atmosphere; and it is only in this latter inorganic mixture that we find nitrogen, that element which, as we have just seen, aids so materially in the latest plant changes, and is yet more abundant in the blood and muscular tissue of animals.

The marked resemblance between the energy-infusing and mo-

difying power of the animal nervous fluid—if such it be—compared with the great agent, promotive of vegetative development, electricity, as well as with the earth-modifying volcanic power, and the probability of their having one common origin, the sun, was somewhat dwelt upon in the third chapter; and attention was next called to the strong analogy existing between the arrangement of radial cells around a nucleolar spicule, in the mineral as well as in the vegetable and animal tissues; where the cell had long been recognized as forming their fundamental structures, liquid as well as solid.*

It seems unnecessary, regarding the supposed analogy existing between the functions performed by various vegetable and animal organs, and several terrestrial phenomena, to do more than call attention to the details laid down in chapter third, on pages 84 *et seq.*

Concerning the prevalence of certain vegetable and animal types at different geological periods, types bearing an analogy to the progress of the earth's development—just as in the utero-gestation of the human embryo, the fœtus resembles successively the least, and finally the most highly organized beings—a considerable number of facts were brought forward.

These tended to prove that cephalo-thoracic organs and anterior extremities, or those first formed in the ovum, were predominant in early geological fossil remains, as well as now in boreal regions; that later the organs of vegetative life and the terminal extremities

* In comparing various structures, we must always, as already mentioned, in order to avoid error, be certain to examine them from corresponding points of view. Thus the bones of the head compared with the long bones, or with vegetable growth, or with minerals, or rock layers, should all be examined either in sections made *parallel* to the plane of the diverging materials, or else all in sections *vertical* to them. In one case the flat bone of the skull would be viewed from the *punctum ossificationis;* the long bone of the arms or the trunk of a tree would be sawed across for examination; to judge of coral, we would look down on its polygonal cell-faces; to examine a mineral, we would view its minute crystals collecting in stellar form around a nucleus; to compare with these the earth's crust, we would take a bird's-eye view, as from the summit of a granitic pinacle, around which we could imagine the concentric edges of successive upheaval or deposition arranged in layers. In the other case, to be consistent in our examinations, we must split down through the thickness of the skull and view the cells from their sides as they elongate from the frontal sinus of an ox to form the base of his horn; or cut lengthwise of the humerus and see the laminated cells; we must cleave the fossil coral from its base to its terminal cells; we must split the wood in planes parallel to its trunk, and study the earth's crust where horizontal layers are spread out beneath the eye.

were more common, and that in the very latest period there appeared a tendency in the endo-skeleton to become external, in the form of repeated limbs, of thickened skin,* of long tushes, of thorns, scales, spines, etc.; among plants, perhaps more particularly to originate woody thorns or spines, leafy stipules, etc., as well as prickles, and hairs of dermal growth.

Among those organisms, too, of matured geological epochs are most commonly found at the present day the highly concentrated poisons in animals as well as in vegetables, the most active medicinal agents, the most pungent and highly colored and abundant sap-products.

Among the minerals of those geological formations are also more common the powerful acids, the hydrochloric salts, the virgin metals, (silver and gold, mercury, etc.,) and the allotropic forms of pure carbon and clay, (diamond, oriental ruby, and sapphire.)

In anomalous Australia, and occasionally in some adjoining islands, were traced the placental peculiarities evinced in the many leafless trees, the sap to form which had been arrested in the petiole. A placenta, being a medium designed to keep up a communication between matrix and embryo, would naturally, when detached from both, give rise to types having this function suspended. Again, that country offers the leaf to view frequently in a vertical position, without epidermis, as well calculated to exhale by one surface as by the other. In the animal kingdom, the type is intermediate between intra and extra-uterine development, between oviparous and viviparous mammals.

Attention was called briefly to the analogy in the periodical changes in the three kingdoms, (the practical inferences deduced from which it was expected to discuss in Chapter VII., but the hygienic aids suggested by which, it has been concluded to reserve for the corollaries in the latter part of this chapter;) and I will here only refer to a column on this subject in the large Tabular Synopsis

* It must be remembered that excessive heat and cold sometimes produce the same effect. Thus, cold thickens the bark on the north side of trees, and consolidates the woody fibre, as heat does by evaporation of fluid parts. Cold thickens the skin of the Arctic and Antarctic savage, as much as heat does that of the equatorial Guinea negro or the rhinoceros. Intense cold blisters the skin like a burn; intense cold breaks off the frostbitten limb: too much heat sometimes produces natural amputation by gangrene.

or Diagram, No. VI., and add that the same is visible in the vegetable world in the ascending sap, in the peculiarities of infloresence, etc., as well as in volcanic dynamics giving rise to earthwaves, outbursts, etc., probably at somewhat regularly recurring intervals. On page 87, when alluding to this subject, I did not call attention to the possible connection between these and the periodical national development, mentioned on page 130.

The subject was also broached as to the greater prevalence of cephalo-thoracic diseases in the North, and of abdominal in the South; also as to the possibility of diseases sometimes emanating in the form of mephitic vapors or gases from beneath the earth's crust, more especially at the junction of separate geological periods, and as to the further possibility of their following these lines of junction in their progress from the typical matrix to the typical embryo. This was hinted at because it was hoped it might aid in suggesting sanitary measures.

It was also thought possible that in the chemical changes which we see going on around us, we behold typified others in organic life: such as the regular conversion of starch into sugar, of that into vinous materials, affording alcoholic products by distillation, again of vinegar, etc., by passing into the acetous fermentation, and finally of gaseous products, by putrefactive decomposition, ready to enter into new compounds. All this resembles the gradual development of the vegetable, as well as, in the animal, the early alkaline digestion converting farinaceous food into grape sugar, the more extended acid digestion of histogenetic material, the elaboration and excretion of acid and decomposable materials, furnishing ammonia for the nourishment of plants.

A certain amount of heat, light, electricity, or nervous influence, is required in all this.

Again, the change in animals from extreme youth to riper years, then to maturity, and finally to decay and death, are of the same character, ay, even in man. In infancy, the fatty tissue indicates carbonaceous predominance; in youth, more histogenetic rotundity is visible; in mature years, with prudence, there is not much change or waste of material, and there is the greatest amount of vascular and nervine energy; while in old age, the nucleus is expended in excretions that may produce acid accumulations, or occasionally adipose tumors, etc., of extraneous growth; and finally, after oxyda-

tion of all the tissues, the whole physical man decomposes into elementary substances, calculated to enter into new combinations.

Having thus made a brief summary, I will close it by again quoting from the Principles of Zoölogy, by Agassiz & Gould. At page 152 we find the following:

"These considerations are important, not only from their bearing on classification, but not less so from the application which may be made of them to the study of fossils. If we examine attentively the fishes that have been found in the different strata of the earth, we remark that those of the most ancient deposits have in general preserved only the apophyses of their vertebræ, whilst the vertebræ themselves are wanting. It would be the same, were the sturgeons of one of the American rivers to become petrified. As the apophyses are the only bony portions of the vertebral column, they alone would be preserved. Indeed, fossil sturgeons are known, which are in precisely this condition.

"From the fact above stated, we may conclude that the oldest fishes have not passed through all the metamorphoses which our osseous fishes undergo, and consequently that they are inferior to analogous species of the present epoch, which have bony vertebræ. Similar considerations apply to the fossil crustacea and to the fossil Echinoderms, when compared with the living ones, and will probably be true of all classes of the animal kingdom, when fully studied as to their geological succession."

We now proceed to draw the practical inferences which we hope it can be made to appear would naturally follow as corollaries, if the above summary be admitted as mainly true. That many of its details will be disputed, I fully anticipate; that some may be disproved, I am prepared to learn; that in a few instances I may have been hurried into inadvertencies of detail which a schoolboy could point out, would not astonish me; but, *if the generalization is true as a whole*, I shall feel quite satisfied.

The *Practical Inferences* may conveniently be divided into those affecting us physically, mentally, and morally. I begin therefore with such as I hope would lead to

PHYSICAL IMPROVEMENT.

For convenience, the inferences to be drawn and suggestions to be made under this head may appropriately fall again into several subdivisions.

The influence of *Diet*, in connection with other modifying agencies, may first occupy our attention, such as the importance of varying it according to age, constitution, predisposition, climate, season of year, amount of exercise taken, and numerous other attendant circumstances.

If it be true that disease most frequently arises from excess of some material, formed or retained in the system, sometimes however from a deficiency, then, is it not highly important that we should be aware of these peculiarities; that chemists and physicians should bring their best aid to bear in prescribing the proper dietetic rules, after making allowance for diathesis and the numerous varying circumstances mentioned above?

Should it really be the case that, under the influence of a scrofulous taint, a northern climate and injudicious exposure, or even without all these, an individual is seen verging towards that state in which too rapid lung-combustion, too great an oxidation of the aërating tissues, takes place, and probably too great a retention of effete albuminous matter, then, in accordance with the views already laid down in various parts of this Essay, it would be well for the patient thus threatened with *consumption* either to remove at once to a climate where less oxygen would be inhaled at each inspiration, namely, to a latitude where the temperature is uniformly mild, or else to meet this excess of oxygen—which acts on the tissues for want of other material—by offering, in the diet, chiefly *carbon*, under some combination. Now we know that the muscle of lean meat is highly nitrogenous; whereas, fats, oils, farinaceous vegetables, and alcoholic* beverages, are highly carbonaceous. Hence the great success of cod-liver-oil. Hence, too, the propriety of giving a fair trial to a diet destitute of much lean meat, replete with nutritious cereals, chocolate, and similar diet. At the same time, a due action of the skin should be kept up by judicious and careful ablutions, by constantly renewed canton-flannel (cotton) undershirts, by moderate exercise, particularly on horseback, or in a vehicle not so hung as to prevent jolting.

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* Physicians who have had frequent opportunities of making post-mortem examinations of the bodies of dissipated characters, give testimony that no inebriate ever exhibited tubercles in the lungs: the remedy, although in such case as bad as the disease, may point the consumptive to a moderate use of similar articles.

I am well aware that practitioners, for whose opinions I entertain the highest respect, recommend their patients to case themselves in woollen flannel, and sometimes even in soft leather undergarments; but I have made the trial so repeatedly myself,* that no one could induce me to adopt woollen undershirts. Not that I have ever had the slightest tendency to pulmonary disease, but I perceived when I wore flannel and omitted bathing, I was much more subject to colds and rheumatism, in various climates and at various periods, than when clothed in good, new cotton-flannel. This material is a sufficiently good nonconductor of heat, yet does not keep up an undue irritation and consequent relaxation of the seven millions of pores, which Dr. Wilson estimates as about the number, occupying the surface of the body, in an ordinary man. Many persons have given bathing a trial and have found themselves worse; but perhaps they were injudicious in their mode of applying the water, which at first may be used tepid, or only by friction with a coarse towel. It cannot be safe to permit *twenty-eight miles* of perspiratory tube, which the same author calculates as being the aggregate amount upon the body of an average-sized man, to remain closed and clogged with effete matter.

Sometimes a counter-irritation may be necessary, in more advanced cases, which can be produced by friction with croton oil.

Undoubtedly, however, immediate removal to a temperate climate would be most advisable, if practicable, when we observe, by reference to the tabulated statistics on page 141, that there were *six* deaths in New Hampshire from consumption for every *one* in Alabama, and the proportion of three and a half in New York to one in Louisiana.

I have dwelt at some length on the curative means to be adopted for this disease, because it is in Great Britain and in the Atlantic States so fatal and so prevalent. The countries presenting the greatest immunity from the disease are chiefly situated in Tertiary or other late geological formations.

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* We are all apt to judge by our own experience; and I may remark here, once for all, that I do not wish to effect more by such observations as the above, than to induce individuals to make judicious and safe experiments for themselves regarding diet, clothing, exercise, bathing, etc., etc., urging them only to the adoption of that course which, after a fair trial, is dictated by unbiased judgment.

Even that direst calamity, *Insanity*, may perhaps be diminished by very strict attention to diet, in connection with change of climate, and the adoption of effective measures for the removal of effete material. This disease, as already alluded to on page 147, exhibits itself sometimes in the form of false impressions made upon the brain by extraneous causes, in such a manner perhaps as to prevent one hemisphere of the brain from exercising the controlling and correcting influence, which seems to be the design of that dual arrangement of the organ. Some maniacs know they are doing wrong when they commit acts of violence, but, like passionate persons, who have never been taught in infancy to bring those impulses under the control of their judgment, they perpetrate numerous acts injurious to themselves and others.

These impulses often come on suddenly, perhaps after a fit of indigestion; are always worse after the use of alcoholic stimulants; and may result from too great a flow of blood to the head, or from that blood being in a vitiated state, charged with albuminous, fermentative, effete materials.

Doubtless, blows on the head, intense mental excitement, the want of sufficient sleep, nature's grand restorative, as well as overtasking the brain, especially at unseasonably late hours, or late in life, when the reparative power is vastly diminished, all these may contribute; but under all circumstances, it might be worth while to give a lengthened trial to a mild, unstimulating, yet sufficiently nourishing diet, such as would be supplied by well-lightened and thoroughly baked cold bread made from the not too fine flour of well-cleaned, sound wheat; slowly-stewed fruit, fresh or dried, not too acid, such as the peach, with occasional variations of wholesome, not watery potatoes or vegetables, an egg, some milk, sago, chocolate, or similar diet: no coffee, no green tea, no spices, no fermented or spirituous liquors. Judging from the proportional excess of insanity in Northern States, a removal South might frequently be worthy of a trial; inasmuch as diminished nervous action may sometimes prevent the system from resisting the climatal changes of the North, and the circulation may be forced, from the extremities, to congest in that organ, where already the greatest amount of irritation exists. Attention to these rules, with abundance of moderately hard, agreeable exercise, occupation and conversation, all combined as far as possible; also the correction of bad habits, such as the use of

tobacco, opium, etc., retiring and rising at early hours, not overtasking the brain, yet not leaving it unoccupied, least of all in solitude, would probably tend much to abate this scourge of civilization.

The above fruit and farinaceous diet will have the additional advantage of preventing or removing *habitual constipation*, the immediate source of many diseases. If diet consists entirely of material which can be assimilated, there is not enough of excreted material to give to the mucous membrane its necessary stimulus: hence the doctrine of the Grahamites, recommending all to leave the bran unseparated by bolting from the flour designed for bread. But the cooked fruit effects the same object with less irritation to some constitutions, and, fairly persevered in twice a day, at breakfast and dinner, for some weeks or months, has never failed, in the numerous trials to which I have known it submitted.

In case of the opposite effect, *diarrhœa*, being brought on, as it usually is, by some error in quantity or quality of diet, producing irritation, as well as where some error has led to occasional indigestion showing itself by disturbed sleep, I have known spiced syrup of rhubarb* act like a charm both on young children and on grown persons, rendering more powerful and dangerous remedies, especially those which check the excretion, but retain the offending matter, wholly unnecessary.

In *dysentery*, out of some hundred cases which I have seen treated, I never knew one which did not yield to salts, followed after due time by opium; the doses repeated if necessary, and connected with a diet of arrowroot, sago, tapioca, slippery-elm water, or other mucilaginous and farinaceous diet, with total abstinence from the stimulus of animal food.†

Eating too fast, and swallowing food without sufficient mastication, are not diseases, but are bad habits, to which we are prone,

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* The aromatics stimulate the nervous power to increased action, while the rhubarb acts as a muco-incremental agent.

† In connection with abstinence from animal food in dysentery, this may be a suitable place to say, that for nervous temperaments, judging from my own extended and repeated experience, animal food is unnecessary and often injurious. I have labored hard, physically and mentally, for years without animal food, and then have returned to it again, without any material inconvenience. However, we all know that we cannot use our brains very efficiently after a full meal of animal food; and

and which are merely pointed out to be avoided, as they may eventually lead to much suffering and chronic disorder of the stomach and bowels.

Diseases of the *liver*, producing a thousand ills, real and imaginary, might perhaps be avoided by the use of fat meat, where there is an undue excess, and by total abstinence from such, as well as from butter and vegetable oils, (this does not apply to the small quantity, of mild character, found in chocolate,) besides using, in the latter case, nitro-muriatic acid when the disease has so far progressed that remedial agents, other than dietetic, are required.

The use of much *fresh baker's bread*, before the gases generated have had time to escape, and while the crumb forms in mastication a tough dough, besides rich pastry, late suppers, etc., have been too often commented upon as injurious, by men like the distinguished Dr. Andrew Combe, of Edinburgh, to require more than a mere mention here.

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although flesh diet may furnish only a wholesome stimulus for lymphatic temperaments, if I desired to obtain the best mental results, I would as carefully abstain from stimulating diet, as a trainer would avoid a watery potato or some trashy innutritive and indigestible vegetable, if he desired the greatest amount of physical strength, on or about a certain day. Let him however pass that day, and his strength soon declines; besides, he becomes more liable to disease. The over-stimulated brewer, and the pampered brewer's horse, are proverbially subject to acute diseases; and when injured, the blood is so overcharged with albuminous material, that wounds, fractures, etc., heal with difficulty and with tendency to fester, or throw out unhealthy pus. It may further be well to allude here to the fact that, particularly in infancy, when nature is forming bone, muscle, etc., etc., it is very necessary that a sufficient amount of these materials should be furnished by a due variety of diet; but some of the ingredients may be in minute quantity, as we learn by an analysis of milk, which contains all the necessary aliment for histogenetic and calorifacient purposes; or in the egg, which has also many formative materials, and is too rich to be taken in large quantities. It is evidently unnecessary, with their large amount of nervous energy, to furnish to youth highly stimulating food or drink, condiments, etc. So too, usually, with the female sex. They are more nervously excitable, upon the whole, less commonly called upon for the full exercise of the muscular power, and less exposed to intense cold, etc., which might justify a generous meat diet.

If students, and persons of sedentary habits, will continue to overload both stomach and brain, they ought to expect, sooner or later, to experience evil consequences. Undoubtedly, the Esquimaux, who has been hunting his walrus all day in a temperature below zero, may be able to digest blubber, which might throw a delicate organization, in warm latitude and unexercised physically, into a state of intense suffering.

Roots generally are less stimulating, but also less nutritious than grains and fruits; and especially if watery, may prove very insufficient diet to develop a fine race of men, physically, morally, and mentally; perhaps the too exclusive use of the potato, even when good, may have contributed, as contended by William Cobbett, to retard the mental progress of portions of Ireland.

The degradation of some California Indians, called root-diggers, and living in as fine a climate and not far from the same latitude as the finely developed nomadic Comanches, may arise partly from their inhabiting a late Tertiary, almost Quaternary formation, and partly from their use of an inferior diet, continued through a long series of generations.

The longevity and freedom from disease of some rice-eating nations, proves that, where sufficient farina is present to be converted into grape-sugar, as well as some of the other necessary elements, *the seeds* of a cereal may give health and strength, although the root or the leaves of a plant might prove insufficient.

When animal food is used, it ought not to be the tough, indigestible fibrin-remnant, obtained after all the nutritious juices have been boiled or fried away; but should rather consist of a moderate amount of meat, obtained from a conscientious butcher, who kills only the most healthy and well-fed animals, prepared by a judicious person, who neither undercooks nor overdoes the meat, and who employs no undue amount of lard or even of sweet butter.

Much more might be written with advantage on this important subject, but perhaps it may suffice here to call attention not only as above to the varied quality of food, and the necessity for more information and experience on some dietetic points, but also to the undoubted fact, which cannot be too strongly enforced, that errors in *quantity* are even more prevalent and more injurious than errors in quality; and that, although a few among the crowded laboring population of some cities may suffer from insufficient nutrition, nine-tenths of the "evils to which flesh is heir" might be wholly avoided, or at least greatly mitigated, if the mass of mankind adopted a reasonable, rational system of living, prescribed rather by judgment than inclination, a system which would soon become agreeable from habit, and would render the sum of human happiness greater than it can be under present circumstances.

Before closing these observations on the peculiarities of vegetable

and animal substances, one or two miscellaneous remarks occur as worthy of notice.

Carbon, under many of its forms, is highly indestructible, and therefore not calculated by its decomposition to furnish materials for nutrition, although by its combination with oxygen it keeps up animal heat. Albuminous matters, on the other hand, are more readily decomposed. Substances calculated to check decomposition, in other words to preserve things, are usually the product of a decomposition arrested in its vinous or acetic stage by elimination of all the diastase or fermentative matter. Thus, many liquors may be kept an indefinite period, after being frequently racked off from the flaky sediment which contains the ferment. Alcohol not only does not decompose, but will preserve any other substance from decomposition. So also pyroligneous acid, creosote, tar, as well as many aromatics and resinous matters, "apparently formed* by the oxydation of essential oils," as well as the more solid stearoptens† or camphors deposited from these oxygenated volatile oils, have a preservative quality. The same may also be said of many mineral salts,‡ and of bituminous products, the analogues of the vegetable resins.

Many of our most powerful medicines are vegetable alkaloids, obtained from plants produced in tropical climates, whereas the bland, soothing, emulsive gums, etc., are often the product of a boreal flora.

Chemical analysis will doubtless give much more information than we yet possess regarding the peculiar elements which affect the human system so wonderfully for health or disease in certain articles of diet and medicine.

That a *large* amount of nutritive material is not required, especially after maturity, when growth has terminated, and that one point very essential to health and strength is the power of diffusing healthy formative fluid, blood, is proved by the fact that thin, moderate-eating, not very muscular, but broad-chested men are gene-

* Silliman's Chemistry, page 459.

† Ibid, page 461.

‡ Does it not seem evident that although a *small* quantity of salt may *promote* stomach-digestion by the hydrochloric aid furnished to the gastric juice, or a small quantity of alcohol arouse for a time to greater action, *large* quantities of salt or of alcohol would be calculated to harden and to preserve the chimifying materials, preventing that incipient decomposition essential to full chylification?

rally capable of enduring great hardships; just as the horse, technically known as having "great bottom," is seldom of a plump, symmetrical form, but invariably has great thoracic capacity for play of heart and lungs, that is, great thickness and depth back of the shoulders, and is usually short-backed as well as being often cat-hammed. The beefy limb may be indicative of strength, but seldom denotes durability or freedom from disease in a horse.

On the other hand, that defective or unsuitable nutrition may be remedied, even after some years of growth, is proved by the success of those benevolent efforts, which by removing the Cretin from the unfavorable influences of his birth-place, chiefly in Switzerland, have gradually, by change of diet and careful culture of the senses, raised him from a condition infinitely inferior to that of a moderately intelligent dog, to bear some resemblance in body and mind to the more favored portions of the human race.

Exercise may be selected as another subject claiming due attention if we desire to improve. Independently of any ethical considerations, as to whether he who does not work should be permitted to indulge freely in the fruits of other men's labor, we may well ask: Can a man enjoy what he eats, even supposing his claim to it indisputable, if he has not earned at least an appetite by a sufficient amount of physical exercise? The reply would usually be in the negative. Even if he enjoys it, for some time, his dyspepsia, his megrim, his dropsy, his gout, and a thousand other ills, admonish him to obey nature's laws, or suffer the consequences. Even ignorance of the fact that we are breaking those laws, will not protect us from the consequences. The only remedy is to acquire a knowledge of those immutable decrees, and to live in accordance with them, when known.

Even the plant requires exercise for the distribution of its cambium, as proved by the experiments of Mr. Knight,* who showed that when both the stem and branches of a tree were confined so that they could not be moved by the wind, "the plant became feeble, and its growth much inferior to that of a similar tree growing in a natural state."

Can we wonder then that the girl who confines herself closely to the house, or who is prevented by parents or boarding-school teach-

* See Mrs. Marcet's Conv. on Veg. Phy., vol. i., p. 114.

ers, ignorant of hygienic principles, from taking the necessary exercise, especially in early youth, should become pale and sickly, or even fall a victim to the injudicious treatment of those who bitterly bewail their loss?

Who, on the other hand, has not felt his own life-blood throb with healthfully quickened pulsations, when he has vaulted on to the back of a thorough-bred horse, the noblest of the brute creation, and dashed off over turf or heath, amid the joyous companionship of intelligent friends?

What sight can be more beautiful than to see a graceful maiden, whose form is well set-off by the neatly-fitting riding-habit, curbing her well-trained palfrey with a bit, sufficiently powerful to render his playfulness safe, yet mild enough not to check too suddenly the "free bound?"

What young man of sense, gazing on the bright glow and animated expression called forth by such healthful action, would not rather select for his life-time companion, and for the mother of his children, the possessor of such requisites to happiness as might reasonably be expected to be secured if such rational exercise is continued, and accompanied by equal good sense in other things, than to trust his domestic happiness to the hot-house frailty of over-stimulated nutrition, and the mental evanescence of frivolous, novel-engendered precocity?

Perhaps there *is* one sight even more beautiful than the above picture which we have sought to paint in no overwrought colors, but only in its true Claude-Lorraine tints of glowing nature. It is that of sportive infancy, with the rounded features which Raphael has so beautifully represented in his various pictures of "The Infant with the Madonna." It is the sight of innocence engaged in infantile sports, enjoying the fresh air which heaven exhales, exercising the limbs which nature has given for the enjoyment resulting from unrestrained movement, and evincing towards each other, in their conduct, the early power to restrain passions, beneficial when controlled, but highly injurious when permitted to exercise a mastery.

Why not then let this innocence, this exercise, this immunity from serious cares and sorrows, be prolonged through their due period? Why hasten prematurely into the turmoils and decay of life?

Among the inferior animals, naturalists have observed that the period of life is usually five times that of growth, and the same probably applies to man.

Thus the horse has "a full mouth" and has commonly attained his height at five; consequently, lives often in a natural state until he has reached twenty-five or thirty years of age. Man usually acquires his stature, if not precociously forced, about his twentieth year, and would live, if he were rational, unavoidable accidents excepted, until he attained his four-score years and ten, or even his five-score. But unfortunately, particularly in the United States, whose Anglo-Teutonic inhabitants are derived often originally from the most energetic and enlightened of the European stock, there is a natural desire, but one against which we must bring our best judgment to bear, rapidly to mature—too rapidly, alas! for soundness—pecuniarily, physically, and mentally. Young America, take warning! Let the period of innocent enjoyment, of invigorating amusement, of freedom from care, be prolonged; lay the foundation of health and strength, of innocence and virtue, before all other requisites. With these, and a good education, the rest will follow and endure: longevity, wealth, distinction, family enjoyment, and a tranquil old age of prolonged usefulness and of extended virtues. If such is to be our portion, individually and nationally, let us begin in time, let us regard health-giving exercise as a cardinal virtue.

Perhaps one obstacle is the stigma which is attached—notwithstanding the efforts of poets and orators to establish the "Nobility of Labor"—to certain kinds of useful and necessary work. This arises doubtless from the fact that many, who are necessarily compelled to overwork themselves physically, are uneducated in mind and manners. If *all* labored moderately because they considered it a useful, necessary, and healthful duty, this prejudice would soon wear away. At our colleges, young men should be taught to help themselves, to perform many little offices for themselves, such as the West Point Cadet and the soldier are not ashamed to exercise. The drill, so useful to the citizen soldier, might be taught; a gymnasium should be as absolute a requisite as a school-house or a college-building. Inducements might be held out and facilities afforded for the student to cultivate, each one, his small garden-plat, thus developing his muscles, diverting his thoughts and actions from improper pursuits, giving him experience in the most independent

and useful of all manual labor, the cultivation and development of soil-products.

A volume might be written on this interesting topic; but the object is attained if serious, reflective thought has been awakened on this important subject.

Even when arrived at maturer age, why should we devote our whole life and energies to making and grasping wealth or its representative, until we are unfit to enjoy the pleasures it aids in procuring?

In the Appendix will be found a short sketch of such aids as might be provided to ameliorate the hard routine of daily business, without draining our purses or encroaching on those hours which nature, by kindly surrounding our planet with stillness and darkness, evidently designed for sleep and renovation. The recommendation will there be read, to construct gardens for exercise and amusement, in which might be combined picturesque scenery, shady walks, the display of instructive objects in nature's three kingdoms, the sound of attractive music, and the sight of chaste statuary; facilities for listening to lectures, conveying practical information, besides the opportunity of refreshing with such necessary adjuncts for temporal comfort as would prevent any feelings of lassitude, yet not stimulate to the boisterous, senseless mirth of an overheated brain.

REMEDIAL AGENTS

may next occupy our attention, for a short period, chiefly as affording occasion to reïterate the statement, how much better it is to prevent evils than to endeavor to remedy them. When, however, notwithstanding all our care, we find our health failing, let us without delay, at once, frankly and fully confide to the physician, in whose judgment we have the most confidence, all the symptoms which bear upon our case, and conscientiously follow his advice. The rational physician, who endeavors to follow natural laws in his prescriptions, will avail himself at first of such mild therapeutic aid as will usually effect the object, if the consultation has been asked for in the incipient stages of disease; and our constitutions may frequently be spared the shattering which many have suffered from necessary and powerful remedies, or from the ignorant prescription of illegitimate practice.

In this profession, as in every science, there is no doubt much yet to be learnt. As in the punctured pearl muscle (*Meleagrina margaritifera*) the irritated gland may give forth its excess in a pearly concretion of excessive deposition; as the tree, while the cellulose of its sapwood is consolidating into the lignin of the duramen, may, if the cambium is arrested or over-stimulated, and thus over-supplied, throw out its unseemly amorphous excrescences; so too, perhaps, the excess of albumen or fibrin in the blood may give rise to certain diseases, a deficiency of those materials to others; or calcareous matters in excess may perhaps be deposited in glands or other organs, forming the hardened variety of bronchocele, the tubercular deposits in the lungs, and the chalky concretions of arthritis, (gout.)

When careful diathesis has proved wherein consist the immediate as well as remote causes of disease, when chemical analysis has demonstrated the elements composing abnormally retained, effete matter, as well as the various constituents of articles, dietetic and therapeutic, then we may hope rationally to prescribe prophylactics and remedial changes of diet, climate, pharmaceutical doses, etc., with just hopes of success; just as the enlightened agriculturist supplies to his land the wants which scientific analyses have pointed out as requisite.

At the same time, the conscientious practitioner will urge among the most powerful preventive agents (prophylactics) abstinence, as *individuals*, from over-nourishment and over-stimulus, the delay of maturity, to the period prescribed by nature, by avoiding excessive heat, excessive and luxurious living, the intense mental excitement, at too early an age, of theatrical representations, overwrought novels, late hours, etc.; and will thereby evince his patriotism in delaying at the same time *that national premature and speedy decay* which history proves has invariably followed in the footsteps of *national luxury and dissipation.*

This last word itself calls up a host of ideas which demand language in expression more powerful than flows readily to the pen of a writer endeavoring to make all his statements under the dictates of a cool and unexcited judgment. In the Appendix are given a few extracts called forth by the wishes of those laboring in the great cause of Temperance. Self-control, without the aid of societies, may be most desirable, but if the virtue cannot be acquired

in later life, without such social aids, let us at least not discourage their advocates in their benevolent labors.

Before closing the subject of remedial agents, it may be well to revert again to the aid to be derived from a natural ebb and flow, which appears to exist in all fluid matter.

There seems in every thing a regular rise and fall, progress and decay. Nothing is stationary. Even in health we have a regular exacerbation twice in twenty-four hours; in disease, those periods are sometimes diurnal, sometimes nearly tertian, occasionally hebdomadal, or perhaps semi-monthly, etc. Hydrophobia has been known to recur a year after the bite of the rabid animal was inflicted, the wound healing and remaining without symptoms of irritation until a short time before the annual reflux.

Every moment, in our pulsations, we have the epitome of the diurnal exacerbations, every day the type of the annual changes; every year, that of a lifetime, every lifetime, that of secular family dynasties, every dynasty, that of national cycles, and every cycle is but the epitome of the gradual development and subsequent decay of our own terrestrial planet: all is fashioned on one and the same glorious yet ever-changing type.

Perhaps, in health and disease, we may avail ourselves of this regular recurrence. Thus habit, as well as natural flux* and reflux, may produce a greater flow of gastric juice and of bile, at suitable and habitual intervals, than when meals are uncertainly protracted; sleep and other habits should, as a general rule, be equally regular; the promotion of certain excretions and secretions might be aided when nature was herself making the effort; or undue flow be checked, by operating when nature was at her ebb.

We pass on now to such inferences as may aid us in effecting and securing

MENTAL IMPROVEMENT.

Education, to be complete, must be equally directed to the development of the physical, intellectual, and moral faculties.

* In this connection may be mentioned the fact, that Liebig found the maximum quantity of sugar in milk obtained about noon, while the amount of fat increased from morning towards evening, the protein and specific gravity remaining about the same. (See Scientific American, vol. xiv., page 96.) Perhaps in the category of periodicity belongs also the hibernation or long winter-sleep of many animals.

Already, above, we have spoken of the importance of those who have the direction of young persons understanding and laying down, for the guidance of the youth under their care, such hygienic principles as will secure health; and we endeavored to point out the importance of sufficient fresh air and exercise.

In mental education, a somewhat extended experience may permit the suggestion, that more time should be devoted, especially in early youth, to acquire a *knowledge of things:* leaving until somewhat later in life the study of language and other keys to knowledge. It seems, also, important that information should be gained more through the medium of the judgment, than simply by the aid of uncomprehending memory. And, where so much has to be acquired, if our language could be modified in a manner which some are now attempting, so that each sound should have one and the same representative sign, it would doubtless much abridge infantile labor, and allow it to be bestowed on the acquisition of the names and properties of the many useful things surrounding us through life, and sometimes remaining "a sealed book" even at a late period.

Nature has not bestowed on all the same capabilities, but we can scarcely place a limit to the sphere of utility which may be occupied by mediocrity in talents, when accompanied by untiring energy.

Doubtless a large-sized brain may perform its task more easily and more safely, but perhaps not more effectually, than one of smaller dimensions, prompted by powerful nervous energy.

Even those dimensions may be increased by use, according to the principles laid down in Axiom I. Organs develop by judicious use: when we lose the power of one organ, Nature compensates for the deficiency, by giving greater energy to another. So, too, if we fail to employ an organ, it loses its capabilities. We cannot readily believe that the sightless catfish of the Mammoth Cave was called especially into existence for that locality; but rather that the obliteration of the organ (or its reduction to a rudimental depression) resulted from its disuse or the absence of any necessity for its employment.

While endeavoring, however, to cultivate faithfully the talents with which a beneficent Creator may have gifted us, let us do so judiciously, and in accordance with hygienic laws. Let us not prematurely overstrain the brain in early youth; let us, when stu-

dents at school or college, duly intersperse our mental with physical exercise; let us in mature age, when supply and waste are pretty equally balanced, still beware of protracting our labors and vigils into late hours, designed by nature for repose; and, especially in later life, when the overtaxed brain draws its materials from the thereby consuming nucleus, avoid the destiny of certain highly-gifted intellects, whose overtasked bodies and minds dwindled down to the fatuitous proportions of imbecile childhood, a warning to their compeers, a lesson to future generations.

Let our mental labors be performed under the invigorating and judgment-cooling influence of Nature's fresh morning air, and be continued some time after a light morning meal, until the noontide arrives;* seldom in the afternoons, which are better adapted for physical exercise; still less in the evening, which should be saved for those social amenities, those family surroundings, which soften the manners, purify the morals, and reinvigorate the fatigued body and mind.

High flights of the imagination may result from midnight efforts of the over-excited brain; but a correct judgment, regarding subjects of philosophical research, is best secured during the cool labors of ante-meridian hours.

MORAL IMPROVEMENT.

Wonderful as is the exquisitely delicate mechanism of the human body, which, although momentarily liable to accidents that may produce instant death, yet performs its functions, sometimes uninterruptedly, for a century or more; astounding as are the intellectual results emanating from the genius of some of Nature's most gifted portion of the human family; yet more wonderful, yet more astounding, and infinitely more important, are the varying impulses produced, for good or evil, by the thousand different surrounding circumstances influencing, moulding, and altering man, from the earliest period of embryonic existence to the last flicker of expiring vitality. Fortunately, an ever-beneficent Providence

* To show that I have sufficient faith in the above advice personally to carry it into practice, I may remark that, hurried as I have been, while writing this essay, I have seldom permitted myself to perform any important labor towards it, other, perhaps, than reading proof or looking up materials, after one or half-past one in the day, usually rising at 5 A. M., and retiring a short time before 10 P. M.

has permitted that the character, in early youth, may be modified, trained, formed, and impressed with lasting lessons of morality, where the necessary measures of wisdom have been applied by the parent, the guardian, by civil authority, or by legislative enactment.

With this conviction before us, we cannot fail to see clearly wherein our duty consists, and how much yet remains to be done.

Let us, in our glorious Republic,—on which the eyes of the combined world are turned for affirmative or negative proof of the practicability of free government and universal suffrage,—let us select men for our legislative halls who are not aspirants to office on account of the wealth and distinction they may gain, but for the sake of the good they may effect.

Let us endeavor rather to *prevent* crime* than to *punish* it. Let not the great struggle be, who can amass the most wealth, who can outshine his or her neighbor in displaying the costly products, manufactured often from the toil of overworked, exhausted human beings, produced sometimes from the very life-blood of our overtasked fellow-men. Little does the high-born lady think, when she heedlessly rends the frail fabric of her Brussels, Valenciennes, or Honiton lace, worn at a ball,—the price of which might feed ten thousand famished mouths for lengthened days,—how many bitter tears it cost a sister-being to form those delicate meshes, and how those drops of anguish, exhaled into heaven's ethereal vault, may waft just accusations of selfishness even to the throne of an offended Deity.

Rather let the great effort be, who shall lead the most virtuous life, who effect the most good, and who be the most wise. What greater source of unalloyed happiness than that of performing a benevolent act; of witnessing our successful efforts in ameliorating the condition of suffering humanity, in rescuing from want a body, from perdition a soul?

* More than thirty years since, my father, by minute calculations, demonstrated to the county of Lanark, Scotland,—whose authorities were then about to expend a large sum in erecting buildings for criminals and misguided fellow-beings,—that the same, or a less sum, judiciously expended in teaching the rising generation their moral duties, would, in all probability, prevent the necessity for any extensive system of imprisonment and correction. Many admit now, as these gentlemen, I believe, then did, the truth of the demonstration, but few, if any, carry the inference fully into practice.

Who that has ever experienced these pleasures will lack a motive for exertion? Who that sees how much remains to be done, and ought to be done, can experience disgust or even languor in existence? Who that has investigated the mysteries of God's works, and looked through them up to their Omniscient Creator, can ever feel that "all is vanity?" Who that rightly appreciates his own benefits, and his own duties, can rest satisfied until he has evinced his gratitude to that Creator, by endeavors to do good to His creatures?

Is there any other manner in which that gratitude could probably be more acceptably manifested, than when each individual strives to understand, and afterwards to point out to his fellow-men, the great laws according to which the universe seems to be governed, and urges his fellow-men, for their own happiness, to an observance of those immutable laws? Is not such conduct in obedience to the will of Him who is Himself the essence of Love?

If the general facts laid down in the foregoing chapters are correct; if man is indeed fashioned according to the numerous circumstances of soil, climate, diet, family relationships, and stock from which he descends, besides a thousand other modifying causes *in his first and earliest years, entirely beyond his control or selection;* does not this furnish the strongest argument for universal toleration?

If the character of my friend, resulting from original organization and temperament, induces him to feel distrustful of the masses, averse to change, even in acknowledged progress, entirely conservative in all his tendencies, inducing him to differ conscientiously from me, why should I, because hopeful and trustful, perhaps over-sanguine and agrarian in inclination, quarrel with him that we do not see alike? Or if he, in approaching the altar of the Most High, clothes himself in splendid garments, and kneels before his Creator to the chime of bells or enveloped in the vapor of diffused frankincense, praying for aid from Him through the medium of a foreign tongue; is it for me vaingloriously to exult over my neighbor and friend, or even over a stranger, that my heart prompts me rather to bow in silent adoration and prayer, spiritually, although not bodily, prostrate in that dust from which His Omnipotence created me? Again I ask, are not these all-sufficient arguments for political and religious toleration?

Let us then, in a word, bear ever in mind the precepts of the great Regenerator of Mankind, embodying the practice of all virtue in that short phrase wherein he commands: "As ye would that men should do to you, do ye also to them likewise."

The duty seems plainly pointed out to the physician, the physiologist, the philosopher, and the philanthropist, to surround all by the most favorable circumstances, especially in youth, before they have a choice; to give all, as far as practicable, some insight into the laws by which their own existence is maintained in healthy action; to regulate advice given in accordance with those laws; to extend to all such a system of physical, mental, and moral training as will most effectually prevent disease and crime; to resort to punishment when absolutely necessary, with the remembrance that the protection of society and the *reform* of the individual are the objects to be kept in view, not the gratification of an unworthy vengeance; to legislate for the best rights and equal protection of person and property, according to the dictates of a dispassionate judgment; and, at the same time, to practice that virtue which they inculcate by precept, as the most powerful and consistent aid to argument.

The young citizen, thrown into society after these sanitary measures have been adopted for giving him bodily, mentally, and morally a fair start in the world, has then himself to blame if, when the Niagara rapids of dissipation and incipient crime have been pointed out to him, he yields to the insane impulse, and plunges into a gulf, whence none can rescue him, and which irresistibly sweeps him onward to the cataract of destruction.

Human nature is weak: the best may yield when temptation is too strong. Let us avoid the first promptings, and divert our time and energies into other channels of interest and utility.

After carefully consulting statistics regarding the most unfortunate of our race, in Prisons, in Houses of Correction, in Penitentiaries, in Hospitals, in Poor-Houses, in Institutions for the Blind, Deaf, Dumb, Idiotic, and Insane, although much yet remains to be learned, and legislators cannot attach too much importance to careful statistical collections and comparisons of causes and consequences, I think there remain yet unbroached three subjects which, without the shadow of a doubt, are among the most important which could occupy the attention of the physiologist or philanthro-

pist; and with these, although much remains yet unsaid, I propose to close. The first of these is the all-important subject of

SELF-CONTROL.

If a young man returns from college speaking half-a-dozen languages, acknowledged a thorough classical scholar, knowing the highest branches of mathematics, an adept in belles-lettres—in short, having graduated with literary honors, and that too without losing his physical health and strength, perhaps his professors and parents think they have faithfully performed their whole duty towards him.

But what will these honors, this knowledge, those prospects, avail that youth, if he has acquired habits of intemperance, if he gambles, or practices other vices: in short, if he gives up his soul to degradation or to crime?

He had better never have been born, than thus to imbitter a father's last days, than thus parricidally to thrust, by the gnawing anguish which will wring her soul, an affectionate mother into a premature grave.

If, however, the father, if the mother, would avert this catastrophe, let them not be satisfied in knowing their children are acquiring knowledge; let them early begin to instil into their youthful minds lessons of virtue; let them check the first indications of rising petulance and passion by firmness, but not by counter-violence; let them, when the gust has passed away, calmly show the evil effects which result; let them inculcate constantly the precept *to act according to the dictates of judgment, not of unaided feeling.* The feelings are often good; they need not be disregarded, crushed, annihilated; simply placed under the guidance of the judgment. As fire and water are excellent servants, but very bad masters, so are the passions. The energy of youth, like turbulent volcanic fires, must have a vent—a channel of outlet: let it be devoted to a useful purpose. As certainly as dangerous earthquakes succeed the pent-up fires of an adjacent volcano, so certainly will youth turn those energies to evil and to crime, unless parents carefully direct them into legitimate channels, and strenuously advocate the necessity of placing them subject to unbiased *self-control.*

The second subject of importance is

MARRIAGE.

Among the records of criminals, how few of them comparatively are found to be married! It is not contended that all are happy in the marriage state, but it is confidently asserted that, if the *judgment* is used in the selection of a suitable husband or wife, before the *feelings* have become too much interested, and if ordinary pains are taken to live up to the duties incumbent upon that tie, the pure monogamic relationship is most in accordance with the laws of nature, most likely to secure health, happiness, and tranquillity, and decidedly most tending to prevent crime. Marriage, for the sake of the female constitution, and of the future offspring, should not be contracted at too early an age; but it should be fulfilled, as a general rule, sooner or later, by all who find partners apparently suited to promote their happiness through life.

Parents, when they interfere, should, as a matter, both of expediency and justice, give only advice, and not continue a useless opposition, still less disown their own offspring, who, if they act from feeling only, owe it perhaps to the fault of those parents in not inculcating early self-control.

But, although marriage is recommended to all, when circumstances favor, there is one rule to be observed regarding the tie, which brings us to the third, and perhaps most important, point of all, in the eye of the physiologist and philanthropist, who desire to use their best endeavors in securing, for humanity at large, the greatest amount of sound physical, mental, and moral qualities, individually and nationally.

As among some Polyps and Bryozoa, thousands of individuals go to form a community, and the decay or death of one or two may take place without occasioning the destruction of the whole, yet affecting its vitality in proportion to the number of the individuals: so, too, man forms part of the whole; and if, being himself diseased or defective, he unites himself with others diseased or defective in some point, be it ever so small, and scarcely perceptible, the defect is doubled in the progeny, the sin is visited on the guiltless child, disease is rendered hereditary in families, and the race degenerates in extended communities. The great rule then should be,

NON-INTERMARRIAGE WITH BLOOD-RELATIONS.

In the language of the motto of one of the literary societies of this University, let us not think of our own selfish gratification, in this or any thing else, but be guided by benevolence and judgment: "*Living not for ourselves alone, but for our country and our friends.*"*

Add to this the precept of the other literary society, as a guide to our steps, and we cannot fail to secure happiness: it is, "*Sapientia et virtute.*"

Wisdom teaches us to acquire a knowledge of the laws which govern the universe, *Virtue* urges us to live in accordance with their teachings.

One of these *laws* is, most indubitably, the great tendency for families to degenerate, when marriages are contracted between blood-relations, and *virtue* demands that we should not contravene that law.

Scarcely a case is known of the intermarriage of near relations, which did not result either in the family dying out without representatives, or in some one member being deficient in important organs necessary to health of body and mind. How important, then, that this great law of Nature should be obeyed!

But, while the union of blood-relations is thus inveighed against, let it not be understood that the crossing of varieties very dissimilar in body and mind is considered most favorable for the improvement of the human race.

Already, on page 135, attention was called to the fact that a union of the Caucasian and Negro varieties, although it produces mental capacity beyond that of the Ethiopian, gives rise to a stock possessing neither the high-blooded nervous and vascular energy of the white, nor the tough, enduring physical constitution of the black race. On the contrary, the mulatto is proverbially delicate and scrofulous.

If the horticulturist† desires to improve the quality of his or-

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* Non nobis solum, sed patriæ et amicis.

† The stock-raising agriculturist adopts the same policy in his selections among the lower animals. With the exception of the hybrid mule, he selects stock from one and the same variety, and in the choice of individuals, although he compensates for a deficiency by a selection where that want is not apparent, he carefully avoids extreme contrasts in size and configuration.

chard or garden-products, he grafts, say the limb of an apple tree, which he knows has borne finely-flavored fruit, on the branch of a hardy apple-stock, possibly the wild-crab; or he inserts the bud of a peach tree, known to produce luscious drupes, into the twig of a hardy peach-stock; but he rarely grafts limbs into the root—he never grafts stone-fruit scions on to the stock of a pome-bearing or of a coniferous tree.

Nature does not divide her numerous products into kingdoms, departments, classes, orders, genera, species, and the like; although, for the convenience of studying marked differences, those arrangements facilitate. Yet she brings into existence individuals differing thus most materially. The more, however, our knowledge extends, the more intermediate links of gradual, almost imperceptible, junctional change are presented to our wondering gaze.

So, too, we find the greatest amount of physical, mental, and moral excellence combined among the varieties of the human family inhabiting Secondary and Eocene Tertiary countries, where no very violent extremes of heat or cold exist, and where a due admixture of inorganic materials is found. It is among those nations, therefore, that we must seek for sufficient variety to correct the tendency to the delicacy and irritability, partly original, partly the result of high civilization, observable in some of those branches, with the more phlegmatic and hardy constitution of different ramifications from a similar stock. Thus the intermarriage of a person rather nervous, and perhaps over-lively, is often indicated, in nature, by a preference for one moderately quiet, sedate, and not remarkably sensitive. A somewhat masculine lady often accepts a husband having a less decided amount and mobility of nervous energy, and *vice versa*. The blonde may prefer, in others, dark complexion, hair, and eyes; although, I think, in the majority of cases, rather the opposite holds good.

Connections have often proved suitable between Irish and Scotch, Scotch and English, French and Germans, etc., although perhaps this result is not always to be depended upon. Anglo-Teutonic branches have given origin to fine nations; the Celtic is infusing itself favorably into other races, etc., etc. But nature has implanted a barrier to too great diversity of union. Hybrids rarely continue their species, and are commonly the result of art or acci-

CONCLUSION.

Having thus endeavored to give a hasty sketch of such generalization as tends to convey—how very imperfectly, how *most* imperfectly, I cannot avoid feeling—the idea which so forcibly impresses my mind regarding the beautiful and symmetrical harmony that prevails throughout the three kingdoms of nature, there remain only a few parting words to be written, before bidding a final adieu to the reader.

In justice to the subject, not to myself, I must repeat, that this Essay has been written under such disadvantages of hurry, as to prevent my giving to the subject one tithe of the clearness, power, and importance it would certainly acquire if sustained by the various facts and arguments which time and deeper investigation would bring to bear.

I feel, and must express the feeling, how utterly I have failed in conveying more than a mere portion of the impressions I so vividly experience myself, and so earnestly desire to arouse in the reader, regarding the ineffably beautiful, the transcendently wonderful works of Omniscience.

That I have shadowed forth, perhaps with boldness, the conceptions presented to my mind, a generous public may be willing to grant; but that I have failed in clearness of explanation, and in closeness of demonstrative reasoning, will probably be too readily perceived.

In the use of terms, if I have sometimes selected those not in most common use, it was either to veil certain passages, deemed necessary in the fulfilment of a high duty, but designed for the physiologist alone, in the drapery demanded by refined taste; or it was to employ language considered more expressive than the com-

moner phraseology, or else to vary the monotony of too frequent repetition; the language was never adopted for the sake of non-committal obscurity, never for the display of mere high-sounding words.

If I have failed, in quoting from the works or citing the opinions of scientific writers, to give full credit, and do ample justice, I hope the error will be considered not as intentional, but as inadvertent; and if esteem for the labors and character evinced in contemporary productions has often elicited a spontaneous tribute of heartfelt admiration, I hope it will not be considered that I anticipate a similar reciprocal compliment.

Having, contrary to custom and probably contrary to experience regarding the best system, written the preface before preparing the body of the text for the press, this is the only opportunity now afforded me of stating, (as a proof of my expectation to see errors pointed out, requiring correction,) that the original contract to stereotype these few pages was modified to printing them. This was done in view of future corrections, should more than one edition, notwithstanding the dryness of the subject, be ever asked for by the public.

To the indulgent reader, who may have had patience to accompany me thus far, I now, in closing my short and very imperfect work, return my grateful acknowledgments.

My task is done; and there remains but one more pleasing duty to perform: To approach again with reverential devotion the throne of the Most High, in order to express to Him the sense of boundless gratitude felt for His Infinite Kindness.

Language utterly fails to convey an idea of the intensity of adoration and wonder experienced, when endeavoring even to shadow forth a partial conception of an inscrutable Supreme Intelligence, illimitable in extension, eternal in duration, immaculate in virtue, omnipotent and omniscient in the works of His Universe, immutable in the decrees of its government.

We can only bow in silent awe and admiration; but, knowing His unspeakable goodness, we can safely trust all to His never-failing Justice and Mercy, His boundless Benevolence and Love.

In the fond hope that the vivifying principle of our dust-created bodies, emanating from the Divine Creator, may again return to Him, let us consign our souls cheerfully and unhesitatingly to His eternal safe-keeping.

APPENDIX.

NOTE.

The Appendix is designed to contain a collection of such details as there was not time to arrange systematically under each appropriate head, and which are now given simply as having some corroborative bearing on the generalization embodied in the Key; it will embrace also such as were accidentally overlooked. They will be classed under the heading of the chapter to which they are considered as more especially belonging; and where some facts present themselves which it is thought may prove useful in their tendency, and, while not entirely irrelevant, yet do not strictly belong under any of those heads, they will be found beneath that of "Miscellaneous Facts or Suggestive Hints." Extracts from others will have the name of the work and page given; when not so accompanied, the responsibility will rest with myself.

These will be followed by some selections, chiefly from former writings of my own, enlarging upon points of importance in the text, which, if introduced in the form of foot-notes, might too much have marred the attempted continuity of reasoning.

APPENDIX.

CHAPTER I.

STATICAL GEOLOGY.

For a list of rocks, composed wholly or partly of animal remains, see Mantell's Medals of Creation, vol. i., page 21.

A rock has been found by Colonel Morgan, in Tennessee, very similar to the lithographic slate of Solenhofen, and submitted to the lithographer in Nashville, Mr. Wagner, for experimental examination.

Thermal springs are said to be common in Japan.

The springs near Bonn, which are in the neighborhood of extinct volcanoes of the late Secondary or early Tertiary Period, and which burst through brown coal, (as well as the Seltzer water,) are charged with carbonic acid.

The sulphur springs near Edinburgh, (as St. Bernard's;) those at Moffat, (North-east Dumfrieshire,) Baden-Baden, etc., are saline; so are those of the Blue Licks and Drennon Springs.

Are the high tides in the Bay of Fundy due to the junctional outcropping of the Crystalline and Secondary Rocks?

Hot springs exist in the Azores. See St. John's Geology, p. 24.

Hot springs exist near Etna and Vesuvius. Ibid, p. 58.

Hot springs exist in Pyrenees, Alps, Java, Oregon, Arkansas, Virginia. Ibid, p. 59.

I found hot springs near Monterey in Mexico, warm enough to cook an egg, welling up within a few feet of a quite cold spring. Germans have informed me that some of their springs will scald a hog, which requires a temperature of at least 155° Fahrenheit.

Regarding submerged land in the Pacific, see Mrs. Somerville's Physical Geography, p. 149.

Did a submerged Pacific Continent disappear when the present greatest mass of land was gradually raised above the level of the Atlantic?

Perhaps quicksilver, the only metal liquid at the ordinary temperature of the earth, may become a solid, when portions of South America, so recently formed, shall have passed by successive changes of the earth's poles into an arctic latitude.

Would it be possible, by following up the facts which analogy in the vegetable and animal kingdoms assigns as the relative periods for developments of different portions of seeds or eggs compared to the final maturity of the plant or animal, at all to approximate to the probable length of the geological periods, and the final duration of the earth?

Thus, few animals live more than a century; some trees live a thousand years, and a few are said to be five thousand years old or more. Let us assume that the most aged plant averages fifty times the duration of the age attained by the longest-lived species of animals; then perhaps, in an arithmetical ratio, the earth might exist until it was fifty times five thousand years old, equal to two hundred and fifty thousand years. If again we assume that the life of the animal exceeds the germ-development one hundred times, while the life of the vegetable exceeds its germ-development only ten times, then perhaps, in the mineral world, each geological period, importantly and markedly separated by its fossil flora and fauna from another period, may have occupied one-tenth part of the supposed duration of the globe; in that case, twenty-five thousand years. Assigning one such period to the Early Azoic, one to the Palæozoic, one to the Mesozoic, one to the Tertiary, and one to the Recent Formation, (of which latter over one-fifth, nearly six thousand years, is estimated to have elapsed since the earth, in its present form, was recalled into a new existence,) then our planet is still in her prime, and may endure yet some one hundred and fifty thousand years, notwithstanding the threatening comets. Of course this is

mere speculation, and I attach little importance to it; yet it may serve possibly as a hint for others to make estimates leading to more definite-looking results.

Professor R. Owen, of London, has shown that the British horse, and several species of animals now living, are specifically the same as those found fossil with the mammoth, etc. (Mrs. Somerville, p. 442.)

"It is not at all impossible that there may be motions like tides, ebbing and flowing in the internal lava." (Mrs. Somerville's Physical Geography, p. 160.)

Gold and platina are chiefly found in the *east* side of the Ural Mountains, but on the *west* side of the North American Sierras, because the centre of separation commencing in Europe, the above would form the outer portions of the volcanic wave-crest.

Regarding fossil resin, amber, etc., see Scientific American, Vol. XII., p. 120.

Regarding the bottomless pit in Mammoth Cave, Ibid, p. 121.

Regarding Cannel coal, at Cranston, near Providence, Rhode Island, Ibid, p. 121.

Regarding Meteoric Ironstone in Mexico, Ibid, p. 137.

Regarding Subterranean river at Henderson, Ky., Ibid, p. 139.

Regarding Virginia gold mines, Ibid, p. 10.

Regarding Malachite in Siberia, Ibid, p. 16.

Regarding Gold in North Carolina, Ibid, p. 57.

It is estimated that nineteen hundred trees are necessary to make an acre of coal. Ibid, p. 74.

Lead found in Connecticut. Ibid, p. 110.

Bitumen is found in Virginia, Kentucky, Ohio, Pennsylvania, New York, Burmah, etc. Ibid. p. 53.

Fossil Forests in Nova Scotia coal-field, near Bay of Fundy. See Lyell's Manual,* p. 321.

Water, probably, during the Palæozoic Period covered the great basin of the Mississippi Valley. Ibid, p. 329.

For an account of the Ninety-Fathom Dike, in the Newcastle coal-field, and other interesting dislocations of strata, see the above author, p. 64.

It is supposed this was produced by the same power alluded to at

* English Edition of 1852.

page 131 of the "Key," which upheaved hills between England and Scotland, (forming a national distinction, sustained by the border warfare on many a well-contested field; a distinction unnecessary to be maintained, in two countries so nearly allied, if care is taken that the equality of representation and rights agreed on at the union is conscientiously observed.)

For a full description of *Recent*, or Post-Pliocene, as defined by the same acutely discriminating author, see his Elements, p. 112.

Height of important *Mountain* chains, as given in Fitch's Outlines of Physical Geography:

Highest peak of the Rocky Mountains, Mount Brown, 16,000 feet, in latitude 52° N.; highest peak of Sierra Nevada range, Mount St. Elias, 17,900 feet, in latitude 59° N.; highest peak of Appalachian chain, Mount Mitchell, North Carolina, 6476. See pp. 22, 23, 24.

The Ozark Mountains range from 1000 to 2000 feet high.

The highest point of the Colombian Andes (Chimborazo) is 21,415 feet;* the highest point of the Peruvian and Bolivian Andes (Sorato) is 21,286 feet; the highest point of the Chilian Andes (Acongagua) is 23,994 feet. Ibid, pp. 25 and 26.

Mountains of Guiana, about 11,000; of Brazil, 6000.

The Appenines, the same author (p. 29) estimates at from 3000 to 5000; the Pyrenees, at from 7000 to 8000; Dofrafield, 5000 to 8000; Ural, 1800 to 2000. At p. 30, he gives the highest Asiatic mountains (the Himalayas) as averaging from 18,000 to 20,000; (Colton's Map gives Kunchinginga, 28,178; Dhawalagiri, 28,073; and an English officer or officers lately, according to newspaper statements, determined one peak as even overtopping these.) Hindoo Coosh (according to Fitch, p. 30) averages 18,000 to 20,000; Ararat is 17,260, Sinai 9300; and at page 32, while the mountains in Africa are said to be from 3000 to 9000 feet high, there are some in South Africa said to attain even 20,000 feet.

For many more interesting facts bearing on this subject, such as quantity of lava, and sometimes sulphuric acid, emitted by some volcanoes, continuous lines of volcanoes, constant activity of Stromboli, changes of level attending earthquakes, amount of salt in various lakes and different parts of the ocean, quantity of mud

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* As given in Colton's New Atlas, Plate 59, Chimborazo is only 21,120 feet high.

brought down by rivers, facts regarding Atlantic soundings and isothermal lines, etc., etc., consult the same valuable work, which, it may here be remarked, should be used in all schools.

For an account of a Peat deposit found near Madison, Wisconsin, estimated at 348,820 tons, see the Louisville Journal, of January 30th, 1857.

The Pennsylvania coal-field afforded in one year 2,000,000 tons of bituminous coal, and over 7,000,000 of anthracite. See Scientific American, vol. xii., p. 165.

For some mention of Alum in China, see ibid, p. 153.

For some mention of amount of Salt in the earth, see St. John's Geology, p. 16.

The north-east coast of the United States is observed to be rising. Ibid, p. 61.

The Currents in the Ocean. Ibid, p. 35.

It is calculated that it would require 1000 years to raise the bed of the whole ocean one foot by means of the present alluvium brought down by rivers. Somerville's Physical Geography, p. 84.

Regarding parallelism of Mineral Veins, see ibid, p. 45.

Regarding similar formations in Sweden and in Finland, see ibid, p. 46.

The same formations found in England are continued into Belgium and part of France.

"The maximum height of the Barometer in western Europe is between the parallels of 40 and 45°." "At most places there are two diurnal maxima and minima heights of the barometer." For further particulars on these points, see Som. Ph. Geogr., p. 278.

Dr. Blackie informs me the following is somewhat the character of the Medicinal Waters named below:

I. *Saline Aperient:* Carlsbad, Bohemia, Marienbad, Kissingen, Seidlitz, Pultna, Cheltenham, Epsom, Leamington, Harrowgate, Northwich, Ashby de la Souche, Dumblaine, and Pitcaithley.

II. *Alkaline Waters:* Carlsbad, Marienbad, Kissengen, Pultna, Scydschutz, Ems, Töplitz, Wiesbaden, Harrowgate, (perhaps Baden-Baden and Homburg,) Scarborough, Cheltenham, Leamington, Bath, Vichy, Mont D'Or.

III. *Chalybeate Acidulous:* Bonn (?), Spa, Pyrmont, Schwabach, Aachen, Seltzer, Tunbridge, Harrowgate, Peterhead.

IV. *Sulphurous Springs:* Aachen, Bareges, Harrowgate, As-

keron, Kedlestone, Moffat, Strathpepper, (Aberdeenshire,) St. Bernard's Well, near Edinburgh.

In England these are cold; on the Continent, hot.

For an Alphabetical Table of the most noted Mineral Waters in Europe, exhibiting their Medicinal Properties and Contents, see Encyc. Brit., vol. xiv., p. 121 *et seq.*

Pure iron is rarely found; some is obtained in Connecticut, United States, also in South America, chiefly as meteorites with nickel; see Fowne's Chem., p. 228. Crystalline form probably the cube; ibid, p. 229. Nickel is found in the Hartz Mountains; ibid, 235.

Fine large cubical crystals of Lead are obtained from Galena, Illinois.

Common Salt and Fluor Spar (fluoride of calcium) also crystallize in cubes.

Silex (as proved when we rub glass with silk) furnishes, usually, positive electricity, and is consequently an electro-negative body; Resins (as evinced by the friction of sealing-wax) usually give negative electricity; hence are electro-positive bodies.

"Out of 380 Minerals known to Häuy, 82 were found in and around Vesuvius." Lyell's Principles, p. 369.

Ashes and pumice of Vesuvius made up of Diatomaceæ; ibid, p. 372.

SYNOPSIS OF CHIEF LOCALITIES IN WHICH CERTAIN MINERALS ARE FOUND; (INFORMATION OBTAINED GENERALLY FROM DANA'S MINERALOGY.)

Nitrogen: In Western New York, Virginia Hot Springs, Buncombe County, North Carolina, and Wachita, in Arkansas.

Carburetted Hydrogen: In Western New York, about Lake Erie, etc.

Amber: Around Baltic, (abundantly,) Poland, Sicily, China.

Bitumen: In Coal generally; *Asphaltum:* in Derbyshire, Albania, Persia, India, Birmah, Dead Sea, Caspian, Sicily, and Island of Trinidad.

Sulphur: Sicily, Spain, Switzerland, Iceland, Teneriffe, Java, Hawaii, New Zealand, Deception Island.

Sulphuric Acid: South America, Java, East Indies.

Muriate of Ammonia: Etna and Vesuvius, Sandwich Islands, Egypt, Ignited Coal-Seams.

Nitre: Mammoth Cave, Kentucky, and other Kentucky Caves, India, Spain, Egypt; in hot weather, after copious rains.

Glauber Salts (Sulphate of Soda): Sandwich Islands, Genesee Falls, Austria, Hungary.

Natron: Egypt, Tripoli, Mexico, Lake Maracaibo.

Common Salt: Pyrenees, Spain, Poland, Hungary, Tyrol, Bavaria, Upper Austria, Silesia, Bex, in Switzerland, Africa, Persia, India, Cashmere, China, Asiatic Russia, Peru, New Granada, Great Salt Lake in Utah Territory, some Salt Lakes in Northern Africa, Arabia, (the Dead and Caspian Seas are also salt,) Khoordistan, the Pampas Plains, and Western New York.

Borax (Bi-borate of Soda): Peru, Thibet, and Ceylon.

Boracic Acid: Tuscany Lagoons.

Sulphate of Baryta: Connecticut, Virginia, and Kentucky.

Witherite (Carbonate of Baryta): in Cumberland and Lancashire.

Strontia (Celestine, or Sulphate of Strontia): In Western New York and Pennsylvania.

Gypsum: Troy, New York; Mammoth Cave, Ohio, Illinois, Virginia, Tennessee, Arkansas, and Nova Scotia.

Carbonate of Lime: Massachusetts, Western New York, and Virginia. Granular Limestone in Eastern and Atlantic States; also in West Tennessee.

Fluate of Lime: New Hampshire, New York, Shawneetown, (Illinois.)

Phosphate of Lime: Spain, Tyrol, Bohemia, Essex and Orange Counties, New York.

Magnesia: Epsom, Seidlitz, Arragon, Chili, South Africa.

Hydrate of Magnesia: Hoboken, (New Jersey.)

Potash Alum: Germany, France, Glasgow, Cape Sable.

Soda Alum: Solfataras, Italy, Greece, South America.

Turquois: Persia.

Quartz: In New York, (sometimes containing Anthracite,) in Massachusetts, Lake Superior, Hot Springs, Arkansas, Switzerland, etc.

CHAPTER II.

DYNAMICAL GEOLOGY.

Possibly it is when dry weather has failed to supply the moisture which acts as a conductor between the layers of earth to throw off disturbed electricity, that the accumulation produces rents, earthquakes, discharges from volcanoes, etc. Lieut. Gilliss gives some interesting facts bearing on this point, in his work already quoted from.

We cannot look at the wearing effect produced in a single year by the washing of a rivulet, or even at that of a single heavy shower, without being struck with the fact that such causes (acting year after year, age after age, not only mechanically, but chemically, aided too by the atmosphere, frost, etc.) must have a powerfully modifying effect on the surface materials of our globe.

To the general reader a word or two more regarding the supposed position of our planet, relatively to the sun, may render the attempted explanation more intelligible: If we place a small globe with movable horizon and meridian in such a position, on a cup-shaped stand, that the present equator coincides with our horizon, and imagine the sun, for the time being, pouring down its direct fervor on the equatorial portion of Africa, the earth, as a planet, would then occupy the position relatively to the sun which it is supposed to have done in the earlier geological periods. If while it performed one revolution around the sun, it revolved also once on its own axis, it must then have presented, as the moon now does to the earth, always the same hemisphere, with the region now occupied by equatorial Africa (then submerged, and having South America as its superposed layer) exposed to the sun's direct rays.

As the new southern land expanded and came to the surface of the waters, under solar influence, some depression on the North Pacific portion of our planet probably occurred, and the place of submerged earth-crust was supplied by a lighter material, water. The mass of the land upheaved gradually in the region of North America, Europe, and part of Asia, say not far from M. on Map 1, offered a denser body for the sun's attraction, which occasioned that gradual change (especially when South America and Australia became partially and finally wholly detached) which resulted in the

northern portion of Africa coming vertically under the sun's rays. In other words, the plane of the earth's progression round the sun no longer coincided with the plane of her own revolution; and the great nebulous tail or expansion towards the sun having become gradually absorbed, the earth's crust having also gradually separated as above supposed, under solar influence, and having expanded to the extreme limit on the sun-facing or land hemisphere of the earth, the general consolidation, as well as the altered relative proportions of land and water, permitted and required a new and quickened-revolution. Thus the diurnal as well as seasonal changes were brought about, which fitted our planet for the residence, in the Tertiary Period, of land mammals, and finally of the most highly organized animal, man. In the same manner possibly, at some future time, the moon may by varying circumstances be rendered habitable.

It will be observed, notwithstanding all these changes, that nearly all the land on the globe (all indeed except a small portion of South America, and most of Australasia, including the Pacific Islands) still occupies one hemisphere, while the Pacific Ocean occupies the other. This may be readily seen, either on the globe, or on Map 1, where the lines N^{I}, X^{I}, N^{II}, represent the great circle of division between the two hemispheres.

It was very natural, under those circumstances, that geological upheavals should exhibit themselves along planes which showed an internal force acting from the centre to the circumference; at first, coincident with the axis of the earth's own revolution, (now diurnal,) at a later period coincident with the axis of revolution around the sun. In both cases, the masses acted upon separated along planes at right angles to these axes: viz., in one case along the equator, and in the other case along the ecliptic.

The greatest continuous extension of land is either on a line parallel to N^{I}, X^{I}, or to X^{I}, N^{II}, on Map 1.

The above supposed expansion of one portion of the earth's crust does not necessarily conflict with the consolidation of the planet as a whole, particularly by the condensation already mentioned of the previous nebulous extension (as well as that extending to the moon) which would be necessary to give to the earth its increased axial revolution; inasmuch as the smaller the volume of that mass, the greater the angular velocity at the diminished periphery.

Whether or not we allow the sun's attraction to have produced the axial change, while the crust was developing, we must at least admit the principle, that a relative change of the solid materials on the earth's surface would occasion a change of the centre of inertia, and consequently a change of the axis of revolution.

CHAPTER III.

ANATOMICAL GEOLOGY.

The Hypogene Rocks, like the closed serous sacs, dip into, envelop, mould, strengthen, and protect other structures.

All nature seems revived and quickened when the terrestrial exhalations, purified and arterialized in celestial skies, shed their benign drops on a thirsty soil.

In discussing *periodicity*, allusion was omitted to the various periods of fever-crises; also to the almost invariable regularity (observable, at least, in our Middle States) of moderately increasing warm weather, while the wind is from the south; then usually rain and a change of wind to the north, with comparatively cold weather, gradually again ameliorating as before: these changes recurring, perhaps, in a quarter of a month, more frequently, probably, semi-monthly.

For interesting details regarding the development of the ovum, consult the admirable "Principles of Zoölogy," by Agassiz and Gould, already so often quoted from. A short abstract of the development of the white-fish may here be extracted: Tenth day, first outlines of embryo or germ appear; head enlarges, and traces of organs to give sight, hearing, and smell are visible. Thirteenth day, backbone and transparent cartilaginous cord, with transverse divisions, (sometimes no farther developed in fishes;) rudiments of eye and ear appear. Seventeenth day, mucous layer divides into two sheets, the interior of which becomes the intestine. Heart (a simple cavity in the midst of a mass of cells) expands and contracts, globules of blood rising and falling; no circulation yet.

Thirtieth day, currents commence running, one to the head, the other towards the trunk, with similar returning currents. Liver begins to form. Embryo gradually disengages itself at both extremities from its adherence to the yolk; the tail becomes free. Organs not yet completed that characterize the class, family, genus, and species. Fortieth day, embryo acquires a proper shape, fins, gills, etc., and we can distinguish the type of the fish. Sixtieth day, escapes now from egg; we distinguish the order, but genus and species are indistinct; yolk suspended from belly daily diminishing in size.

The envelopes are most numerous in highly-developed animals. In fishes, reptiles, and birds, vitelline membrane does not take part in growth of embryo. In mammals the chorion, which corresponds to the vitelline membrane, is vivified, and finally becomes attached to the maternal body, thus establishing a direct connection between the young and the mother.

It will be seen, by an examination of Chapter III., especially of the tabular view at page 80 of the "Key," that the earth is supposed to have developed in a manner analogous to that of the embryo animal and plant. A more detailed comparison of the *two* latter is subjoined, as some additional aid in tracing out the analogy in the *three* kingdoms; it is such as my limited botanical knowledge enables me to furnish.

COMPARISON OF GERMINATION.

VEGETABLE.	ANIMAL.
The *Ovary*, (base of pistil.)	*Ovaries*, (base of uterus.)
The *Ovules*, (future seeds.)	*Ova.*
The *Placenta*, (that part of the ovary from which the ovules arise.)	*Placenta*, (connection between matrix and germ.)
The *Fruit*, (ovary brought to perfection.) It consists of:	*Ovum* arriving *in utero*, (zona pellucida forming chorion.)
The *Pericarp*, (covering of the seed,) and of	*Albuminous coating* of egg, (food-yolk or white.)
The *Seed.*	*Yolk*, or germ-yolk.
The seed consists of three parts:	
1. The *Integuments.*	*Vitelline* membrane, (also umbilical vesicle.)
2. The *Albumen.*	*Vitellus*, giving rise to three layers, (serous, vascular, mucous.)
3. *Embryo.*	*Embryo*, or germinative dot.

VEGETABLE.	ANIMAL.
The embryo, nourished by the albumen, develops into three parts:	
1. The *Radicle*, (descending axis, root.)	*Nutritive* system.
2. The *Plumule*, (ascending axis, stem.)	*Circulatory* and respiratory system.
3. The *Cotyledon*, (source of early nutriment.)	*Uterine* nourishment, (allantoic and placental.)

The analogy may be traced still farther in the fully-developed plant.

The *Outer Bark*, or epidermis.	*Epidermis*, or cuticle of the skin.
The *Cellular Tissue*, (containing resinous, oily, saccharine juices, etc.)	*Cellular* or connective tissue, containing fat, etc.
The *Vascular* and vasiform tissue.	*Venous* and pulmonic circulatory vessels.
The *Lactiferous* tissue.	*Arterial* circulatory vessels.
The *Woody* tissue or fibre.	*Osseous* and muscular system.
The *Medula*, or pith.	*Medullary* substance, or nervous system.
The *Glands*, hair, etc.	*Glands*, hair, etc.

The excretions and secretions are very similar in both, as:

Acrid *poisonous* juices, (of nettles, upas, poison ivy, etc.)	*Poisonous* juices of wasp, scorpion, etc.
Vegetable mucilage, albumen, gluten, and casein.	*Mucus*, fibrin or albumen, gelatin, and casein.
Plants respire carbonic acid and exhale moisture from their leaves.	Animals respire oxygen and exhale moisture from lungs and skin.

In order to institute a comparison between the periods, in the earth's development, when the salts, the bitumens, and various other products are most abundantly found, and the geological formations furnishing the vegetable resins, etc., as well as the parts of the plant, and especially the parts of the animal, containing particular ingredients, consult Draper's Physiology, from which I extract the following: The resinous ingredients of the bile may be detected as far as the lower extremity of the ilium; sugar does not descend beyond the jejunum; the transmutation and reäbsorption of the biliary matter commences in the small intestine, and proceeds continuously, so that when the middle of that portion of the tube is reached, half the bile is gone; salt substances are not found in the fæces, but are removed by the kidneys. Again, at pages 87 *et seq.* will be found the statement that the lacteals introduce such substances as are not absolutely dissolved, particularly the oils and

fats, while the veins appear to take up those substances only which are completely dissolved in water. The lacteals are in reality an appendix to the respiratory system. The analysis of the chyle shows that it is always rich in fat and in albumen; the latter gradually diminishing, while fibrin increases by oxidation of this chyle-albumen. Lymph he considers nearly the same as blood without red cells, differing but little, before it enters a gland, from the serum or liquor sanguinis of the blood. The chyle-vessels present a connection with the respiratory apparatus, the chyle-corpuscles being the embryo of the true blood-cells. The first, previously to the formation of chyle and lymph, are nucleated and capable of reproduction by fissuring; but later they are not nucleated, and incapable of reproduction. The destined function of the perfect blood-cell is the introduction of oxygen into the system. Again, page 114: "For every beat of the pulse 20,000,000 blood-cells die." Page 122: The albumen in the blood is the plastic material from which the soft tissues are nourished and the cells grow: greater in venous than in arterial blood, increased during digestion, and presenting variations in disease. Fibrin is oxygenated albumen, is increased by respiration, and is in excess in acute inflammations; the quantity of cells in blood can be regulated by diet more readily than the quantity of fibrin. There is no gelatin in the blood. At page 125 we learn, that in typhoid fever, fibrin diminishes to one-half; in chlorosis, cells sink to one-fifth their normal standard; and in Bright's disease albumen is greatly diminished.

Some of these observations belong, perhaps, more strictly to the chapter on Pathological and Therapeutical Geology, but being connected with the Physiological portion, are permitted to remain here.

One question more connected with the subject alluded to on page 91 of the "Key," I would like to ask: Is the Pineal gland, (supposed by Descartes to be the seat of the soul,) with its contained accumulation of calcareous matter,* (*Acervulus Cerebri*, consisting of various pieces united by cellular substance and enclosed in a sac,) the central point or nucleus from which expands gradually the whole cerebro-spinal axis, for the transmission of power, traversing the crus cerebri with its diverging strands, along which may

* Phosphate of lime, carbonate of lime and animal matter. See Horner's Anatomy, vol. ii., p. 359.

be sent motive energy from the anterior column of the spinal cord, while the posterior re-conveys sensations from the extremities again to the starting-point; as well as also for emitting the electric flashes of intellect from the region of the superior tubercula quadrigemina or nates, again receiving the impressions collected from the external world, and transmitted by "the windows of the soul" back, through the testes of the optic lobes, into the region of the same original nucleus?

And is the type of this wonderful and complex structure in the human brain to be found partly in the supposed *former* north pole, or decussating point of volcanic energy, partly in the angular junction between stratified and unstratified rocks, at M, on Map 1?

A host of similar questions arise, demanding a hearing, but judgment admonishes me to forbear until the public fiat has pronounced upon the general analogy.

The carbonaceous materials, besides affording internal heat by their oxidation in the interior of the earth, as well as in the animal system, furnish all our artificial sources of light and heat, such as are supplied by the combustion of common gas, of benzole, of paraffine, and of the various kinds of coal from the mineral world; by the resins, oils, lignin, etc., from the vegetable kingdom; and by wax, oils, fat, stearine, spermaceti, etc., etc., in the animal economy.

CHAPTER IV.

BOTANICAL GEOLOGY.

THE most useful vegetable fibre for manufactures is, in the North, obtained from the stem, as flax, hemp, and sea-grass; in the South it is from the seed-vessel, as cotton, the former stronger, the latter more protective.

Vegetable products of *late* geological periods, such as balsams, aromatics, etc., seem less liable to decay than those of *earlier* periods.

Milk poison (there supposed due directly to vegetation) at Herford, Westphalia; see Mitchell's Therapeutics, page 528; in Northern Italy, (Lombardy and Venice,) Ibid, p. 529.

Vegetable narcotics are materially affected by culture, locality, etc., Ibid, p. 472.

The terminal cell of plants develops in the Phænogamia.

Botanical items chiefly furnished by Br. Blackie, viz.: Great Britain, North America, and Germany, fern countries. "*Fairy rings*" observable in the meadows are due to mushrooms.

Mosses develop in winter; spring is the season for monocotyledons.

Cruciform flowers seem peculiar to the European Continent and Northern Hemisphere. Out of nine hundred species, eight hundred belong to the North: they are mild antiscorbutics.

Composite plants form one-tenth of the flora of the world.

These form one-seventh of the phanerogamous* plants of France; one-eighth of those in Germany; one-fifteenth of those in Lapland; one-sixth of those in North America; one-half of those in the Tropics; one-half of those in Sicily and Balearic Islands; one-twenty-second of those in New Holland and West Africa.

The violets of South America are shrubs. The ash of England has neither calyx nor corolla; and some North American species have the same peculiarity.

Orchidaceæ, flowers which, from the great development of one inner petal, termed spur, frequently resemble animals, are chiefly found in the Tropics, only one species in New Zealand, and one in Tasmania.

It is only some ten years since the *Anacharis alcenastrum* first made its appearance in the river Cam, (England,) yet it is already so common in some canals, as to require that they be frequently dredged for the removal of the obstruction they offer to navigation.

The *Diatomaceæ*, crystalline, angular bodies, fragmentary and brittle, propagated by spontaneous separation of fragments, are found everywhere, but especially on the Antarctic Continent.

The *Confervaceæ*, vesicular, filamentous bodies multiplied by zoöspores generated in their own interior, belong to temperate regions, and prefer fresh water no matter how warm. One species give the color and name to the Red Sea; another *Protococcus nivalis* is supposed to cause the red tint of the polar snow.

* There are 95,000 flowering plants known.

Among the *Fucaceæ* or *Fuci*, multiplied by simple external pores and found all over the seas, one, the *macrocistis pyrifera,* has been found 500 to 1500 feet long.

Lichens, purely cellular plants, nourished entirely from the air and the media on which they grow; bear spores in the substance of their own thallus. About 2500 species are known; they are found usually on bare rocks of coral reefs, among the first vegetation capable of sustaining existence, furnishing then a place for andraceæ and other plants to fill up the rocks. Species nearly similar all over the old and new world, north and south. The chief substances entering into their composition are oxalate of lime and some oxide of iron. They grow also on living substances.

Fungales, cellular plants, nourished through their own thallus, grow on decayed animals and plants. This is the largest class of plants known, there being 4000 species already described, and probably 10,000 existing. They absorb oxygen, and exhale carbonic acid. They *abound* in nitrogen, are found somewhat in the tropics, but more especially in extra tropical lands. The air is supposed to be filled with the spores of these fungi, which include every kind of mould. When boleti are broken, the wound heals that of an animal.

The *Equisitaceæ* are fuller of silex than any other plants, even the grasses, (as equisitum hyemale or scouring rush;) spore-cases are peltate, splitting to one side, no operculum. In the plants of this order, each spore has two clavate filaments, called elaters, coiled around its body, which on being moistened uncoil themselves and throw out the spores. Found almost everywhere; are abundant in Holland.

The *Musci* are divided into the andraceæ or split-mosses, (inhabiting coal regions, and growing up to the latitude of perpetual snow,) and the Bryaceæ, of which there are 1100 species. They have valvular spore-cases, with an operculum or lid; are found in every humid atmosphere; are very abundant in temperate regions, and constituted the first vegetation seen on the lava after the upheaval of Mount Ascension. On Melville Island one-fourth of the flora is composed of Bryaceæ.

Lycopodiaceæ or Club-mosses. Axillary spore-cases, one or two cells. Distributed nearly as the ferns; found chiefly in tropical islands, and then not until you reach the azoic, northern regions.

Marsilaceæ. Many-celled radical spore-cases, grow in water in temperate latitudes.

Ophioglossaceæ, Adders-tongues. Ringless spore-cases, two valves on the margin of an altered leaf. Are found in Tropical Asia, very few in Europe and America; none in Africa.

Filices. Spore-cases and rings around them, splitting irregularly. Greatest number in Tropical Islands, as Jamaica, New Guinea, etc. In Jamaica they form one-half of the flora; in the Sandwich Islands one-fourth. In Egypt we find only one in 1000; in Portugal and Spain one in 200; France one in 70; in Scotland one in 30; in Greenland one in 10; at the North Cape one in 7. Altogether, about 2000 species are known.

For the above data, as already stated, I am indebted to Dr. Blackie.

Resins are oxidized essential oils, and often feeble acids.

Bladder Senna (*colutea arborescens*) grows on the top of Mount Vesuvius.

Some of the *Orchidiæ* have the pollen conveyed from the anther to the stigma by means of insects.

Gum Kino obtained in Bengal. Scientific American, Vol. XII., p. 120.

Chinese potato, Ibid, p. 149.

Assafœtida in Persia, Affghanistan, etc., Ibid, p. 152.

Indian Wood oils, (from the Dammara,) Ibid, p. 25.

Grama-grass roots, seventy feet deep, Ibid, p. 80.

Oregon fruit, large, Ibid, p. 105.

Oregon trees, large, Ibid, p. 155.

Gum Benzoin in Siam, Sumatra, Java, Ibid, p. 112.

Ages of trees and plants. Fitch's Physical Geography, p. 171.

Most fruits originated about Syria, Ibid, p. 175.

Cocoa-nut Palm in Ceylon, Sumatra, Java, Ibid, p. 179.

Sugar Cane native of China, Ibid, p. 179.

Coffee native of Ethiopia, Ibid, p. 179.

Potato native of Chili, Ibid, p. 179.

Cassava or manioc, native of Brazil, Ibid, p. 179.

Ovulation, in animals, is similar to flowering in plants. Agassiz and Gould, p. 105.

Barrens of North America resemble the tundras of the Samoyedes, Ibid, p. 166.

Are the prairies of America the result, in the vegetable world, of a law similar in principle to that expressed for the animal world in Axiom XIII. ?

On page 102 of the "Key" is found the expression, (when speaking of the succession of plants corresponding to the geological periods,) "in the above advance from a lower to a higher organization." Perhaps it would be more correct if thereto had been added, "and subsequent return to less perfect type;" and again where in the same sentence the inference is drawn "that vegetation has partaken of the progressive development which we suppose the earth to have undergone," we must also suppose a period of maturity and partial retrogression, in the vegetable type, as there possibly may be after a time in the animal world.

Regarding the changes produced in the vegetable world, by cultivation, soil, etc., much valuable information can be obtained from Sir Charles Lyell's Principles of Geology, pp. 566, *et seq.*

The Plumule or ascending part of the embryo, or the rudiment of the ascending axis of the future plant, (see Wood's Botany, p. 58,) is usually directed towards the chalaza, or point of attachment of the ovule to the nucleus.

In the terrestrial development, the analogous progression seems to have taken place in a plane, the great circle of which passes through Palestine, the Malström, and the American Magnetic North Pole.

The great region of the grasses may be found in the prairies of North America, and in the planes of Chili and Peru in South America, at an elevation of twelve or fifteen thousand feet above the level of the ocean.

Botanists assert that in a single night the *Bovista giganteum*, a puff-ball, can develop from a mere point to such a size that it must contain fifty thousand millions of cells.

The cedars so abundant in Tennessee, and other middle States of the Union, occupy a geographical position very similar to that of the Cedars of Lebanon.

CHAPTER V.

ZOÖLOGICAL GEOLOGY.

CAN the longer utero-gestation of mares casting *horse*-colts (maintained by stock-raisers to have been established as a truth by observation) be due to the fact of male mammals requiring more heat and material for nourishment, while females, like plants, require more light and nervous energy?

Fishes, oysters, etc., poisonous in particular localities, chiefly tropical. See Mitchell's Therapeutics, p. 424.

The fossil Megatherium, Palæotherium, Mastodon, Mammoth, etc., the *Galæopithecus* or flying-lemur, the Elephant, Rhinoceros, Babyroussa, the *Buceridæ* or hornbills, the Adjutants, Flamingoes, etc., the Hercules Beetle, the great Lantern-fly, etc., all animals having large limbs or great dermal development, horns, etc., are found in southern countries.

The fowl from India, now so universally domesticated, exhibits, in its Shanghai variety, enormous size, particularly of limb; and the small Bantam breed gives evidence that, like the bird of paradise, its nutrition is chiefly expended in producing feathers—in one case around the feet, in the other in developed tail-plumage.

The small birds are generally found in Europe.

The Rhinoceros in *Africa* has *no* wrinkles on the skin, although the dermal folds are ample in the *Asiatic* species.

The *Rhea*, or American ostrich, is about half the size of the African ostrich, and has three toes, while the African species has only two toes on each foot.

The Apteryx, of New Zealand, appears, of all birds, to have the wings reduced to the most simple rudiments; and it presents, at the same time, many points of approximation to the Mammalia. Chambers's Elements of Zoölogy, p. 189.

Is not hibernation in animals somewhat similar to the winter condition of plants?

Regarding fossils, the analogues of the present Fauna and Flora, consult Mrs. Somerville's Physical Geography, pp. 445 and 446.

The *Tetrao Scoticus* is found only in Great Britain.

New Guinea has seven different species of Marsupial quadrupeds, only one of which is found in Australia or other islands.

High altitudes in Tropical climates apparently most favorable to silky hair in Ruminants, as evinced by the productions from the Cashmere goat, and from Peruvian Alpaca, etc.

The species of Fishes in the Caspian Sea and Mediterranean are stated to be identical with each other.

Humming-birds are found only in the New World.

Flying-fishes are found chiefly between the Tropics.

The *Tænia lata* and *Tænia solium*, or tape-worm, are said never to attack the same nations, apparently proving that the different circumstances surrounding these nations give rise to different species of intestinal worms.

The *Filaria Guinensis* (endemic in Africa, India, etc.) is a cylindrical worm, which penetrates the heel, and is found, after a time, protruding its head. It should be carefully extracted whole, on account of the great power which the entozoa possess of fissiparous reproduction.

The *Chegre* or *Chegoe*, in the West Indies, penetrates under the skin, chiefly near the toes; it is the same troublesome insect known in our Southern States under the term "jigger."

The poison of some comparatively northern animals (as the rattlesnake) is in the fang of the head, while in more southern animals (as the scorpion) it is contained in the caudal appendage.

Do not the Newfoundland Dogs, the Scotch Sheep-dog, the French Barbette, the Swiss St. Bernard-dog, and some other northern varieties of the canine species, evince more intelligence than is found in the Hairless Dog of Mexico, or the gaunt, scentless Greyhound of Italy?

The heavy fetlock of the Horse is common in Canada, Scotland, and Flanders, while the Barb and the Arab are free from superfluous limb-hair.

The Ass, frequently the Mule, and some Horses, chiefly dun-colored, of Spanish origin, have the crucial streak of black along the back and withers. These are found north of the Mediterranean, whereas the Zebra, Quagga, and other equine species of Southern Africa, have very different marks.

Intelligent stock-raisers have long known that they could, by any

thing like judicious feeding, make a small-boned China hog gain at the rate of a pound per day; when a larger quantity of feed given to a woods-hog, as the common long-nosed, lathy breed is termed in the West, even if it were equally carefully housed and looked after, would scarcely add half a pound per day to its bone and muscle, much less to its profitable lard increase.

This is true also, to some extent, even with regard to some improved northern breeds, such as the Irish grazier and other large-framed varieties, while our improved Berkshires, being originally the inhabitants of an English county in which the Tertiary formation is close at hand, partake in some measure of the fattening qualities of the China breed.

CHAPTER VI.

ANTHROPOGRAPHICAL AND ETHNOLOGICAL GEOLOGY.

Does the considerable resemblance of the North American Indian features to those of the Jew, still more that of some well-formed Malay races, and the circumcision among the South Sea Islanders, point to their Hebrew origin?

The obscenity of the Romans, more than is found among northern nations, is said to be evinced by discoveries in Pompeii and Herculaneum.

Some families have brittle bones, probably from a deficiency of gelatin.

Muscular fibre in man is consolidated in winter by cold, as lignin is in plants.

While Great Britain, Germany, and France have been cultivating the abstruse sciences, depending on the judgment of the head, Italy has devoted herself, latterly, chiefly to the fine arts, depending on the feelings, which we usually ascribe to the heart; but which, perhaps, it would be more philosophical to trace to the susceptibility for impressions made by the afferent nerves. A musician can distinguish differences in vibrations inappreciable to the nerves of a less delicate or less practiced ear.

An Italian gentleman informs me, that at Poretta, thirty-six miles from Bologna, in the direction of Florence, there is a watering-place on a mountain, which he estimates at perhaps five hundred feet in height, in which there is an iron mine. The inhabitants of this locality are blondes, while all in the valley are brunettes. Before deciding on the probabilities of this case, we should require to know whether the same original stock settled on the hill and in the valley.

Metals are most abundant on the Saxony side of the Erzgebirge, or outer slope of the supposed volcanic wave-crest.

Is there not a greater tendency to corpulence among the southern inhabitants of England, living in Eocene Tertiary, than there is among the Scotch, or even than among the English of the northern counties, Northumberland, etc.?

The Mexican women have a decided tendency to obesity, as well as those of Turkey.

There is a marked difference between the inhabitants in the southwest of Ireland and those of the rest of the island; so also between the south-western inhabitants of France contrasted with those in the north. Some of those living near the line of extinct volcanoes, as in Auvergne, have been observed to possess a large amount of nervous mobility.

The Tertiary basins on which London, Paris, and Vienna are built, although contributing, probably, to peculiarities of the inhabitants, being merely outliers of those formations, should not be regarded as furnishing the same surroundings for physical and mental modifications which we find in countries entirely Tertiary: on the contrary, we have here a favorable approximation of some of the most important inorganic elements in the soil, within short distances of each other; thus often producing the most desirable combinations.

For interesting particulars regarding Arabs, see Encyc. Brit., vol. ii., pp. 723 *et seq.*

For interesting particulars regarding Negroes, ibid, vol. i. p. 264.

Their fondness for music and dancing; ibid, p. 271.

Portuguese in an African colony have degenerated into Negroes; ibid, p. 274.

The ancient Scythia is Russian Tartary; ibid, vol. ii. p. 720.

Description of inhabitants of Cashmere; ibid, p. 729.

South American Indians in an abject condition compared to those of the North. Fitch's Physical Geography, p. 194.

For highly important and philosophical observations regarding the distribution, condition, and future prospects of the Human Race, consult chap. xxxiii. of Mrs. Somerville's admirable work on Physical Geography.

The Chinese have large, fat bodies, and very little beard on the lip or chin. Buffon's Natural History, vol. i., p. 62.

I quote further from the same author: "In surveying the different appearances which the human form assumes in the different regions of the earth, the most striking circumstance is that of color. This circumstance has been attributed to various causes; but experience justifies us in affirming that of this the principal cause is the heat of the climate." . . . The varieties which are remarked in Europe and Asia among the whites "proceed solely from those in the mode of living." . . . "When cold becomes extreme, however, it produces some effects similar to those of excessive heat." . . . "Violent cold and violent heat produce the same effect upon the skin, because these two causes act by one quality, which they possess in common. Dryness is this quality." . .

"As the first, and almost the sole, cause of the color of mankind, we ought therefore to consider the climate; and though upon the skin the effects of nourishment are trifling, when compared with those of the air and soil, yet upon the form they are prodigious. Food which is gross, unwholesome, or badly prepared, has a strong and a natural tendency to produce a degeneracy in the human species; and in all countries where the people fare wretchedly, they also look wretchedly, and are uglier and more deformed than their neighbors. Even among ourselves, the inhabitants of country-places are less handsome than the inhabitants of towns; and I have often remarked that, in one village, where poverty and distress were less prevalent than in another village of the vicinity, the people of the former were, at the same time, in person more shapely, and in visage less deformed.

"The air and the soil have also great influence, not only on the form of men, but on that of animals and of vegetables. Let us, after examining the peasants who live on hilly grounds, and those who live embosomed in the neighboring valleys, compare them together, and we shall find that the former are active, nimble, well-

shaped, and lively, the women commonly handsome; that, on the contrary, in the latter, in proportion as the air, food, and water are gross, the inhabitants are clumsy, and less active and vigorous.

"From every circumstance, therefore, we may obtain a proof that mankind are not composed of species essentially different from each other; that, on the contrary, there was originally but one individual species of men, which, after being multiplied and diffused over the whole surface of the earth, underwent divers changes, from the influence of the climate, from the difference of food, and of the mode of living, from epidemical distempers, as also from the intermixture, varied *ad infinitum*, of individuals more or less resembling each other; that, at first, these alterations were less considerable, and confined to individuals; that, afterwards, from the continued action of the above causes becoming more general, more sensible, and more fixed, they formed varieties in the species; that these varieties have been, and are still, perpetuated from generation to generation, in the same manner as certain deformities and certain maladies pass from parents to their children; and that, in fine, as they would never have been produced but by a concurrence of external and accidental causes, as they would never have been confirmed and rendered permanent but by time, and by the continued action of these causes, so it is highly probable that in time they would in the same manner gradually disappear, or even become different from what they at present are, if such causes were no longer to subsist, or if they were in any material point to vary." (London Ed., 1821, of Buffon's Nat. His., vol. i., pp. 74 *et seq.*)

Perhaps a few words should be added to show, after using my best judgment, what belief my convictions have forced upon me regarding the great scheme of the Creator, in his laws for individual, social, and national progress and improvement.

That there is a great diversity among men, let it arise from what cause it may, no one can deny. Mental superiority in a race, or individual, takes precedence of physical; but where both are combined, a highly superior race originates, which naturally assumes its right to make inferior nations and individuals subservient to useful purposes. In carrying out this system, if we view it as part of the Divine Plan for Human Improvement, let us bring humanity and judgment at all times to bear; and when, in exercising these to the best of our unbiased reason, we think we see a path of yet

greater improvement, let us not refuse to enter upon it, simply because it conflicts with some of our more selfish feelings.

Is it any thing more than a coincidence that causes us to find Switzerland and the free towns of Germany, as well as the former Italian Republics, distributed along a line, which does not deviate far from the Alpine line of force?

Does it not seem, in the history of nations, that a due admixture of the northern barbarians was required, at various intervals, to prevent the once more civilized and enlightened tribes from dwindling into insignificance, or becoming exterminated by luxury?

CHAPTER VII.

PATHOLOGICAL AND THERAPEUTICAL GEOLOGY.

THE most favorable countries for averting consumption are perhaps Florida, Bermudas, the Bahamas, Azores, Canaries, Madeira; some portions of France, (as Nice,) and of Italy, (Pisa, Naples,) Sicily, the Ionian Islands, and Malta. These are chiefly Tertiary countries.

Regarding the action of sugar on teeth, see Scientific American, Vol. XII., p. 33.

Regarding checked perspiration, Ibid, p. 64.

Regarding epidemic among fish in Michigan, Ibid, p. 78.

Regarding tape-worm among hog-butchers, Ibid, p. 112.

Twenty thousand persons died of epidemic in Sicily, after an earthquake. See Fitch's Physical Geography, p. 59.

For various interesting tables regarding the difference of heat in different animals and in men under varying circumstances of health and disease, see Dr. Lardner's valuable work on Natural Philosophy, Philad. edition of Blanchard and Lea, 1853, pp. 144, *et seq.*

In Vol. II., p. 826, of Wood's Practice of Medicine, when speaking of palsy, the author says: "There is a diminution of the power of regulating temperature, so that the part becomes warmer and colder more easily, according to the degree of heat of the surrounding medium."

I have observed in my own constitution, (there being often an undue tendency of blood to the head, if the extremities are cold, or the brain overtasked,) that when this is the case, the heat is greatest in the left hemisphere of the cerebrum, while the right side feels colder than the left; indicating that if nature's laws were sufficiently violated to produce apoplexy and paralysis, the chief suffusion of blood would doubtless, in my case, be in the left hemisphere, and the subsequent probable hemiplegia would be of the right side.

Can the enormous development of the cranium, (particularly sometimes I believe of the *ossa triquetra*,) and brain, observed in the Swiss "Cretin," be due to the abnormal excess of the same nervous energy which in a healthy degree produced, in other parts of Switzerland, a Tell, a Werner, a Walter Fürst, a Stauffacher, a Melchthal, and an Arnold of Winkelried?

CHAPTER VIII.

ETHICAL GEOLOGY.

In taking the census of a country, would it not be highly useful to note among the statistics all the facts regarding the parentage, birth-place, nourishment, etc., of the deaf, dumb, blind, insane, and idiotic?

On reviewing the *Summary* in this chapter of the Key, it seems well to suggest that perhaps, (instead of the terms used on page 161, viz.: "It appears that the earth's spore, which we have supposed to be the moon, was thrown off during some great convulsion of nature from the region of the Levant,") it would be more consonant with La Place's theory, and more in accordance with probability, to consider the earlier comet-like extension reaching from the earth to the region of our present moon as being gradually absorbed and consolidated in the manner alluded to in this Appendix at page 205.

Knowing from experience the value of repetition, in order to

make any thing intelligible and to impress it upon the memory, I venture, even at the risk of being somewhat tedious, to supply some deficiencies, which a review of the Summary has pointed out to me. These supplemental remarks will, I hope, suffice to convey to the general reader the idea held out regarding the general plan of development, as being on a system analogous to that observed in the other kingdoms of nature.

If the foregoing suppositions and inferences be correct, the changes which our planet has passed through may thus be summed up:

The incandescent nebulous matter, supposed to be derived from the sun, gradually condensed and cooled on its surface; while thus cooling, the elements, arranging themselves according to the laws of chemical affinity, formed the materials which we now call crystalline or igneous or hypogene rocks. When sufficiently cooled to permit the elementary gases forming water to condense in a liquid state around this crust, it was acted upon by the water, and broken up into larger and smaller fragments. These were carried partly mechanically and partly in chemical solution from those portions of the crust which in cooling were farthest from the centre of the earth, or in other words constituted the highest land, down to the valleys and low grounds, and there deposited as shingle, silt and mud, etc., which, mingling with the decaying animal and vegetable matter, chiefly at first of low aquatic organization, that meantime had lived and died on the crust as it became suitable for such existence, were gradually converted by chemical union, aided by electricity and mechanical pressure, into the more or less hard materials now denominated aqueous or sedimentary rocks.

As these successive layers were thus gradually forming, internal forces were at work, altering and modifying occasionally the original crust by means of the internal fluid contents of the globe, acting chiefly along two great circles (X^{I}, X^{II}, etc., and Y^{I}, Y^{II}, etc., on Map 1,) at right angles to each other, which are considered the analogues of carpellary dissepiments, or original cell-partitions such as are found in the seed-vessel of the plant, and in many animal structures.

During the periods spoken of, considerable portions of the earth's crust were still always, and others occasionally, under water; but from an internal disruptive, expansive (the analogue of germinative)

power exerted along a plane forming an angle of 23½° with that of the previously mentioned expanding and contracting forces, new portions, first in the carboniferous, then in later eras, were raised above the ocean. About the same period we suppose that the gaseous bodies, necessary for an atmosphere, had commingled to settle around the crust and furnish additional oxygenating, nitrogenous, and carbonaceous nutrition or accretion; that crust meantime, under volcanic influence, expanded on its more plastic substrata, until it commenced separating from the central point M, on Map 1, or the same point indicated by the same letter in the developed cube-cover or cell-wall, figured on page 76 of the Key. This would also be precisely the central point in a half sphere-cover, opened along a line from one pole of the earth's then axes of revolution, to the other, viz.: from Behring's Straits to the Antarctic Circle on the south Atlantic side, or, in other words, along the great circle N^{I}, X^{I}, N^{II}.

The above gradual separation continued until the distance from the germinative point to the Magnetic North Pole was equal to the complement of the angle 23½°, viz., equal to 66½°, making the largest continents exactly that length and width, as detailed in Chapter I., while smaller subdivisions of land were measured by dividends of the same. .

This rupture, at the same time, taking place, as just said, from a central point, (the coast of Norway,) scattered broken fragments, larger and smaller, from that point as a centre, and also from the region of Hudson's Bay as a centre, that having become detached from Norway; the boulders being smaller and less abundant as they are farther removed from that centre of dispersion.

The transportation of these materials was probably facilitated by the whole of the later geological formations, comprising all the habitable globe, being submerged at various periods, especially during the great deluge, described in the Mosaic account of the flood, and in the traditionary histories handed down by all nations.

The resulting disturbance of equilibrium occasioned by the condensation of gaseous materials and by this relative change of land and water, while the earth revolved around the sun in a plane at right angles to its then axes of revolution, required some equivalent change to restore the equilibrium. That the alteration in the speed of revolution resulted from condensation, and that the axial change

was effected by the increased attraction of the sun for denser materials, accumulating in some portions, seems consonant with the laws of natural philosophy; but the exact details we must leave to the mathematical astronomer to work out.

The axis of the earth, after that change, was vertical to our present equator, and no longer perpendicular to the plane of the ecliptic, or earth's path around the sun: thus seasons brought their never-ending variety, and, by the increased axial revolution, days acquired their present length.

Wherever the internal disruptive force had brought up outcroppings of the various layers of deposition, that fracture was along lines forming the sides of regular geometrical figures, (see Diagram III., fig. 1,) similar to the primitive form of some mineral crystals, (see Diagram IV., fig. 12^{I},) the analogue of a vegetable nucleus or placenta, as in Diagram III., figs. 3, 4, 5; and the type of the nucleus in animal structures, the type of the endoskeleton in the developed individual.

The earth's crust, thus expanded and disrupted, separated, sometimes vertically, entirely through all its deposited layers, sometimes (particularly in the southern later depositions) by horizontal removal of an upper layer, leaving a lower layer, or *vice versa:* this may explain, on the principle of Axiom XIII., various geographical peculiarities. When we restore the parts supposed disrupted, (as attempted approximately in Diagram I.,) then we find geological formations, as well as geographical mountain-chains, etc., fitting into their original positions.

Some portions of the earth, independent of climatal varieties, were adapted for the nourishment and development of certain forms of vegetable and animal life more than for others; and where certain inorganic materials were wanting, then either the vegetables requiring those materials were also altogether wanting, or were modified in their structure, and the animals had a proneness to certain physical, mental, and moral normal and abnormal conditions.

In other localities, where these inorganic materials were in excess, there the effects on the Flora and Fauna, including man and his diseases, were and still are apparent.

In conclusion, it is required of us, if we would live in accordance with the laws thus developed, and bring man, individually[illegible]l-

lectively, to the maximum enjoyment and exercise of his physical, moral, and intellectual faculties, so to modify our places of residence, our habits, modes of life, our sometimes thoughtless matrimonial connections, etc., etc., as to diminish any redundant or increase any deficient material of the human economy, and thus correct, as far as practicable, local tendencies, or injurious hereditary diathesis.

Possibly (in the same manner that electricity promotes vegetation and nervous agency develops animal growth) the volcanic, electric, and magnetic forces themselves, as well as light and heat, being only modified undulatory motion, emanating from the sun, bear, as already hinted at on page 130 of the "Key," upon the marked secular epochs of historical importance, affecting individual and national rise, progress, and decay.

The phrases, mentioning nervous agency in various places, as enabling the maternal source to transmit to the developing germ, and afterwards to the fœtus, the materials for increase and peculiar modification, are not intended to be used in such a manner as to indicate that I pretend to consider the moot-point among physicians, regarding the extension of maternal nerves into the fœtal system, as decided.

That the mother does furnish nourishment is undoubted; that nervous agency promotes the diffusion and deposition of materials is proved by the diminished energy and shrunken muscle of the paralytic limb.* This diminished energy may doubtless sometimes be the result of the interruption of a sufficient supply of blood,† or by pressure on the nerve, as every one has felt when the limb, in common language, "goes to sleep." No one can deny that the power of nervous energy, transmitted from the brain through the motor nerves to my muscles, may enable me to send a rock of moderate size fifty yards from me; and if I have sufficiently practiced the establishment of a correct sympathy between my nerves and my muscles, I may throw the stone accurately in the direction I desire. Just so, even if there be no nerves traceable through the placental medium, the mother may possess nervous energy sufficient to transmit the materials for increase, modified in their strength

* See Wood's Practice of Medicine, vol. ii., p. 826. † Ibid, p. 824.

and direction by the influence of external agents on the afferent nerves, whether that agency operate with or without the consent of the mother. If it operates without the consent, the impression may be repelled, and produce little permanence, in a mother of strong nervous will; but if otherwise, the fascination may amount to that of the terrified being who rushes on death to avoid it; or of the powerless animal that, petrified by the Gorgon-glance of a snake, approaches irresistibly towards its serpent-fangs.

MISCELLANEOUS FACTS OR SUGGESTIVE HINTS.

ALTHOUGH we cannot hope to avert earthquakes, we may, perhaps, avoid the most dire consequences, by erecting our dwellings on the hard, crystalline rocks, instead of at the junction of strata.

On examining page 130 of the "Key," I perceive reference is made to the Appendix as discussing the influence of *altitude* in modifying organisms; particularly as regards its effects on man. This having hitherto been omitted, a few words are added here:

We are all aware that plants, usually found in the north, may occasionally be met with in high *altitudes* on intertropical mountains. Allusion has already been made to the difference between the heavy broad-hoofed and spongy-hoofed horse of some low countries, and the light, spirited, hard-hoofed pony of higher altitudes.

In the Tabular Synopsis, Diagram VI., the Georgians and Circassians are also observed to have a fairer skin than the nations of the same latitude; and the cause is partly assigned to the higher altitude they usually occupy.

Where great upheavals exist, great volcanic agency is supposed to have been at work; and, very generally, we find in abundance the early Hypogene Rocks, the supposed analogues of the osseous and nervous systems, resulting from the early serous layer. If electrical force has been at work, producing these volcanic evidences, and if the same electrical power can stimulate, as every medical man knows it does, the nervous system, then may not the individuals, born and developed under the influence, partake of th

influence and evince it largely through life: thus furnishing some explanation of certain peculiarities, so observable in the inhabitants of mountainous regions.

Can it be from causes similar to those mentioned on page 147, (namely, the ready fermentation of the blood when certain protein bodies, as diastase, etc., are added,) that the death of the infant* sometimes ensues, when it imbibes the milk of a highly-enraged mother? An addition which, in the adult, would only produce the swelled limb consequent on poison, the delirium resulting from fever etc., may be more than infant blood can bear without destruction.

On looking over the chapter on Anatomical Geology, in the "Key," and also over the portion of the Appendix devoted to that subject, I observe that nothing was said regarding the direction of atmospheric currents, the supposed analogues of the arterial circulation; partly, I imagine, because I felt I was little acquainted with this part of meteorology. But, from knowing the fact that a denser medium, if free to move, will endeavor to restore equilibrium by moving towards the rarer medium, I conclude that, as a general rule, the currents, in some portion of our atmosphere at least, will usually converge from the poles to the greatest mass of equatorial land; also, from observing light clouds commonly to form converging apexes towards the direct rays coming from the sun to the earth, and the aqueous collections around the apparent position of the moon, (forming a halo, always indicative of rain,) I conclude that both sun and moon exert an influence attractive of air and vapor towards the region of their more direct influence.

Fearing I have not yet made myself fully understood regarding the type of creation mentioned on pages 80 and 81 of the "Key," I will here add that the nucleus, formative-fluid, and investing cell-wall are also the type of all change. Thus, in the *nucleus*, we have the type of early birth, or entrance into life: this nucleus, in

* For this and similar facts I here acknowledge my indebtedness to the present worthy occupant of the chair of Physiology in the Nashville Medical College, Dr. Buchanan; as well as my obligations for advice, in this branch, to Dr. Jennings, the former Professor in that department, now lecturer on Anatomy, distinguished for his minuteness of research; and in other branches to Dr. C. K. Winston, and to Dr. Briggs, of the same institution; also to Dr. Watson for the loan of works and the discussion of some embryological points connected with his obstetrical department.

the animal world, is sometimes bone—phosphate or carbonate of lime, or both, with animal matter—sometimes the commencing granule of less solid material; in the vegetable kingdom, it is carbon; in the mineral kingdom, it is the primary crystal or the crystalline mass. The *formative-fluid*—chiefly the oxyd of hydrogen, HO—typifies the passage through life; growth by accretion or deposition of solidifying materials around the nucleus. This formative-fluid is, among animals, sometimes chyle, sometimes serum, sometimes blood, sometimes lymph, or inspissated chyle and blood. Among vegetables, the formative-fluid is the ascending sap, or the same thickened by evaporation,—from watery exhalation in the leaves,—into the descending cambium; among minerals, it is sometimes the water of crystallization, and again the molten contents of a planet sent from its interior to its crust-surface. The cell-wall or investing envelope, nitrogenous in character, furnishes the type of the wasting materials,—the sack, the integuments, the bark, the secondary crystal planes,—which, formed at the expense of the nucleus and formative-fluid, often leave a vacant central space, at the close of the final change; existence finally terminates by the disintegration of mineral matter in the inorganic world, and by a more or less gradual decay or decomposition in the organic world, producing its inevitable destiny, death.

Under the head of Statical Geology, I neglected to mention that some horses' teeth were dug up, while excavating a well in Edgefield, on the opposite side of the Cumberland River from Nashville, Tennessee. They were furnished by the kindness of Messrs. Hobson and Wheless, of the Bank of Nashville, on whose estate the well was sunk. The teeth were found fully twenty feet below the surface of a clay soil, not, as might readily be imagined, in a valley or depression, but on ground considerably elevated. They have been examined by several geologists, who, judging by their weight, hardness, etc., have pronounced them fossil. They exhibit exactly the markings of the *Equus caballus*, as shown by figure 151, on page 392 of the London edition of Owen's British Mammals and Birds. It seems almost as difficult to account for the remains of horses, introduced into America by Europeans, becoming thus covered with twenty feet of clay, in comparatively high regions, and thus preserved, indeed to appearance fossilized, as to imagine them the fossil remains of an extinct horse, such as the *E. primi-*

genius or the *E. plicidens* or the *E. fossilis* described by Prof. Owen, of London, associated with the pre-Adamite remains of the Mammoth, Rhinoceros, etc., which fossil horses we would consequently have to conclude existed and died out in America previous to the Recent Geological Era.

In the Synopsis or Tabular View No. VI., a geographical position is assigned, under the column of "prevailing animals," to the Torpedo and Gymnotus, or electrical eel; and I here merely mention them again, to ask if it is possible that this peculiar agent is another type or form of the greatly-developed energy we remarked in the secretions of tropical plants and animals? It appears due to an effort of volition, which oxidizes the tissues and disturbs the electrical equilibrium, leaving the animal, after a time, as much exhausted as the nervous system of a lecturer, orator, or clergyman might be, when he had thrown his whole energy into the mental effort, which, if continued too long, may waste the materials of his own brain, while it controls the willing minds of his attentive hearers, and sometimes electrifies them with the flashes of his eloquence or his judgment.

Is there a national taste in colors, such as is indicated by a preference among the Scotch for violet, blue, or green, which we see exhibited in some of their plaid tints; or by the fondness of the negroes for yellow and orange, evinced in the selection of their glaring headkerchiefs? And, if there is such an inherent preference for colors, does not the taste correspond to the prevailing tint of flowers distributed geographically in the manner indicated in one column of the general tabular synopsis?

Are the medullary dissepiments the analogues of the *Falx cerebri*, *Mediastinum*, and other partitions for bilateral separation?

SUGGESTIVE EXTRACTS.

Note referred to at page 40.

In speaking of the great natural phenomenon *Charybdis*, it may not be unacceptable to the general reader to peruse a translation made by myself, (while occupied on my farm, in Indiana, in following the plough,) from my recollection of Schiller's beautiful poem, which I had committed to memory while studying in Switzerland. I usually jotted down a verse in my note-book, after the completion of a few furrows, which doubtless varied somewhat, by the mental abstraction, from constituting the "shortest lines between two given points."

THE "DIVER."

"Who dares the venture, knight or squire, of all my court around,
To dive in yonder fearful pool, which yawns a gulf profound?
A golden goblet, rich with gems, I hurl into the deep:
He who can snatch it from the waves, the golden bowl may keep."

Thus spoke the king, while from the rock—a bluff, projecting height—
He threw the cup. Charybdis gaped, and snatched it from their sight.
"Who is there here, I ask again, among my courtiers fair,
That feels his spirit bold enough the fearful leap to dare?"

His courtly train of valiant men in silence hear the call:
A single look into the gulf their courage can appall.
"What! 'mid these knights of princely birth, and squires who court renown,
Is there then none, I ask again, who dares to venture down?"

No: all were silent as before, until, with modest air,
A youth stepped from the trembling crowd, the venturous leap to dare:
Him courtly lords and ladies too with wondering eyes surveyed,
As on the rock the noble youth his cloak and girdle laid.

And as he trod th' o'erhanging rock, and viewed the chasm 'neath,
Charybdis spouted forth its waves, crowned with a foaming wreath:
With noise like distant thunder-peal, they break in stormy roar,
And gushing rise, in their dark bed, to dash against the shore.

It foameth high, it gurgleth deep, it hisses and it boils,
As when, a raging fire to quench, the gushing water toils:
The waves to heaven dash their spray, and heave, e'en from the earth,
As would the sea, with pregnant throes, to other seas give birth.

At length the raging storm is laid, and 'mid the foaming white
Yawns bottomless a chasm beneath, as black as realms of night:
It seemed as though unerringly, to Pluto's dark abode,
The vortex, with resistless force, would sweep the surging flood.

Now quickly, ere with coming swell the waters backward roll,
The youth, with eye and hand upraised, to God commends his soul;
And—cries of horror burst from all—he whirled in giddy maze:
The abyss closed o'er the hero's track; he vanished from their gaze.

The water's surface seemed becalmed: below it rages still,
And deeper howls, as though it strove a vast abyss to fill,
While every lip and every eye the feeling wish express:
"May God preserve thee, daring youth, and thy adventure bless!

"But though the royal crown and throne were promised me as meed,
Yet would not I, like this rash youth, have dared so bold a deed:
No living soul should madly hope the secrets to reveal
Which these dark waves from mortal ken for ever must conceal.

"How many gallant ships have found in this dark pool their doom!
Oft shattered wrecks are spouted forth from this devouring tomb."
Now louder yet 'tis heard to gush, and nearer heard to roar,
As winter-storms through forests rush, or lash the cliffy shore.

It foameth high, it gurgleth deep, it hisses and it boils,
As when, a raging fire to quench, a gush of water toils:
The flood to heaven throws its spray, sea upon sea it pours,
As, peal on peal, in tropic climes the deafening thunder roars.

See! on the bosom of the deep a snow-white neck appears!
A stout arm rows with speed and strength, its course to shore it steers.
'Tis he! and, high in his left hand, see him the goblet bear!
He greets the light; deeply and long inhales the vital air.

The thronging crowd, with eager shout, the joyful news proclaim:
"He's here! is safe! has brought the cup, and earned immortal fame:
From out that vast and fearful depth, a cold and watery grave,
Unscathed, unhurt, the hero comes, whom none could help or save."

On bended knee the daring youth presents his golden pledge.
Bid by the king, his daughter fair fills to its circling edge
The proffered cup with generous wine. The youth his lord addressed
In modest words, while eagerly the crowd around him pressed:

"Long live the king! How blest are they that breathe this wholesome air!
For none can know, who have not seen, the dread things under there;
Nor should they tempt their fate, and seek those secrets to unfold
Which God, in charity to man, forbids him to behold.

"It snatched me down with lightning's speed: then from a rocky cleft
A gushing fountain spouted forth. I, of all power bereft,
Was whirled, with giddy, blinding speed, as would the waters strive
To match in swiftness shafts or wheels which powerful engines drive.

"But God, whose mercy I implored, with fear and faltering breath,
Showed me a rock: I grasped it tight, and thus escaped from death;
And there, close by upon that rock, hung the much-wished-for cup,
Which else had plunged in endless depths, whence none could bring it up.

"For under me 'twas fathomless, in purple darkness set;
And though no sounds could reach the ear, the eye, appalled, was met
By sights of hideous finny tribes, and monsters of the deep,
Of dragons, salamanders, eels, a vast and hellish heap.

"In black and fearful swarms there moved, rolled in a hideous mass,
The thorny ray, th' electric eel, the swordfish and the bass:
The fierce and unrelenting shark, hyena of the sea,
With threatening jaws gaped grimly wide, as if to swallow me.

"Ay! there I hung, and, shuddering, felt my utter loneliness,
And, thus removed from human aid, my abject helplessness:
Alone, in dreary solitude, far from all mortal sound,
I knew myself the only soul 'mid all the monsters round.

"But lo! a cursèd reptile crawled, and stretched its hundred legs,
And snapped at me! In blind despair, I loosed the coral twigs.
A moment more, those jaws had closed: just then the current's might
Bore me, with upward-rushing speed, and brought me safe to light."

Then thus the king, when with surprise he had these wonders learned:
"The cup is thine: this ring besides, with precious gems adorned,
Shall be thine own, if thou wilt yet once more essay thine art,
And tell what wondrous things thou saw'st at the sea's deepest part."

The royal daughter, hearing this, said with a winning air,
"Pray, father, cease this cruel sport! He did what none else dare;
And if you cannot yet control your cruel heart's desire,
Let some brave knight display his skill, to shame the youthful squire."

Thereat the king, with sudden grasp, far in the eddying sea
Hurléd the cup: "If now you dare to bring it back to me,
You shall be knighted on the spot, and shall this very day
Embrace as bride her who for you so fervently did pray."

These words inflamed his daring soul; not death could now appall;
He saw the beauteous daughter blush, he saw her blanch and fall;
Driven by more than mortal power, his eyes with lightning flashed;
Resolved to die or win the prize, down through the pool he dashed.

Again it foams; again it breaks in surges as before;—
She stoops, with anxious, loving look; she hears the deaf'ning roar!
They come, the dashing billows come, a mountain and a glen;
They foam on high, they gurgle deep;—none bring the youth again.

Note referred to at page 66.

The following fable, originally furnished for the "Cadet," (being connected with the fact that the two genera of Brachiopods, the *Lingula* and the *Terebratula*, are both found in the earliest fossiliferous strata, and are still found recent,) I venture to offer again for the amusement of the general reader.

ARISTOCRACY; OR, THE TEREBRATULA AND THE SEPIA.

On a beautifully serene evening, a Cuttle-fish, (*Sepia officinalis*,) in search of small mollusks, its usual food, sank itself to the bottom of an unruffled portion of the Mediterranean Sea.

The quick eye of the Sepia soon detected a Terebratula attached to a rock, and he immediately stretched his formidable arms, or tentacula, to seize the latter, as a small yet delicate morsel. The Terebratula, feeling the grasp of his mortal enemy's suckers, (for he has numerous pairs of natural cupping-glasses on each of his tentacula,) loudly begged to be heard, ere he suffered death. The good-natured Sepia granted the request, and asked what reasons could be urged for deferring his meal.

The haughty Terebratula replied: "You must be well aware that my family is one of the most ancient in the whole animal kingdom. Man, the most perfect of animals, has carefully traced back our history, and decided that my cousin *Lingula* and myself constitute the only two genera of mollusks whose families have existed in a

direct line ever since the most remote epoch of animal life, described by man as the lower Silurian period. Besides, the same rock-built castle which I now occupy has been in the possession of my ancestors for many ages past. We have, therefore, claims which no other animal can set up to the respect and consideration of all the animal creation, but more particularly of our brother mollusks. Even your own now powerful family, as you are well aware, existed in former times only as the *Belemno-Sepia*, of which you are but a branch: this fact might well induce you to show deference towards the ancient Terebratulæ. If you cannot, however, content yourself with limpets (*Patellæ*) and similar shell-fish, you might take some of the oyster tribe or some small sea-wings, (*Pinnæ*,) whose families, though somewhat ancient, have not the same claims that mine has to be termed the aristocracy of the ocean."

The Sepia, being of the modern utilitarian school, replied: "I have been informed that what you state regarding your family is true: but you must bring forward more powerful arguments before I consent to relinquish my prey. If your family is old, the more shame that it should be so useless. You remain for ever indolently attached by a ligament to a bare rock, which you are pleased to designate as your ancestral castle, not doing any good, so far as I know or can ascertain, to others, and very little, I should judge, to yourself. Here you vegetate, merely supplying your animal wants by stretching out your ciliated spiral arms in search of food. As for your neighbors, whom you affect to despise, they are at least of considerable service to others. One of the oyster tribe (the *Meleagrina margaritifera*) furnishes to man the pearls with which he adds lustre to beauty and royalty; and the *Pinna* (besides her friendship for a small and unprotected crustacean, which the poets among men say she guards from its enemies) has furnished man with a material that may be manufactured into articles of the most delicate texture.

"With regard to myself, I admit that my family is, as you say, but a branch from the original Belemno-sepia tribe; but, if we cannot boast of our antiquity, we can at least lay claim to utility. The dark-colored fluid (of which nature has kindly given us an ample supply, for the purpose of defence against our enemies) that

is contained in the ink-bag, is employed by some races of men* as the means of recording all past events, and consequently contributes to future improvement. The same material is used by other nations to represent the various plans for new designs in machinery, architecture, and in the arts generally; so that we indirectly promote the progress and diffusion of knowledge among mankind.

"However, therefore, you may be entitled to the appellation of the *Molluscan Aristocracy*, I see no reason, as you are otherwise so useless, why you should not form a meal for a useful democratic Sepia, who contributes to the general good of the human race."

Saying these words, the Sepia contracted his hitherto relaxed grasp of the Terebratula, and conveying, by means of his acetabulated arms, the fated victim to his mouth, at one gulp swallowed the vaunting aristocrat.

Note to page 66.

The following verses, by the lamented geologist, Richardson, being connected with the subject under discussion, being also very beautiful in themselves, and not much known in this country, (although printed by Dr. Mantell, at the close of a small work of his published in England, entitled "Thoughts on a Pebble,") are reprinted for general perusal.

THE NAUTILUS AND AMMONITE.

The Nautilus and the Ammonite
   Were launched in storm and strife;
Each sent to float in its tiny boat
   On the wide wild sea of life.

And each could swim on the ocean's brim,
   And anon its sails could furl;
And sink to sleep in the great sea-deep,
   In a palace all of pearl.

And theirs was bliss more fair than this
   That we feel in a colder clime:
For they were rife in a tropic life
   In a brighter, happier time.

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* The ink used by the Chinese for writing, and by us for drawing, is generally supposed to be chiefly composed of the fluid obtained from the Sepia.

They swam mid isles whose summer smiles
  No wintry winds annoy;
Whose groves were palm, whose air was balm,
  Whose life was only joy.

They sailed all day through creek and bay,
  And traversed the ocean deep;
And at night they sank on a coral bank,
  In its fairy bowers to sleep.

And the monsters vast of ages past
  They beheld in their ocean caves;
And saw them ride in their power and pride,
  And sink in their billowy graves.

And hand in hand, from strand to strand,
  They sailed in mirth and glee;
Those fairy shells, with their crystal cells,
  Twin creatures of the sea.

And they came at last to a sea long past;
  But, as they reached its shore,
Th' Almighty's breath spake out in death,
  And the Ammonite lived no more.

So the Nautilus now, in its shelly prow,
  As o'er the deep it strays,
Still seems to seek, in bay and creek,
  Its companion of other days.

And thus do we, in life's stormy sea,
  As we roam from shore to shore,
While tempest-tossed, seek the loved, the lost,
  But find them on earth no more.

Yet the hope how sweet, again to meet,
  As we look to a distant strand,
Where heart meets heart, and no more we part,
  Who meet in that better land.

Note to page 126.

While discussing the physical advantages enjoyed by the Nomadic Tribes, I may perhaps be pardoned (although making no pretensions to being a poet) for introducing a few lines descriptive of the feelings which I conceive animate the bosoms of many of those

children of the desert. For a specimen of their fine physical appearance, I would refer the reader to the beautiful portrait of Akīl Aga, in Lieut. Lynch's valuable and interesting account of his explorations in and around the Dead Sea. The verses were originally contributed to our small periodical, the "Cadet."

THE ARAB.

O'er trackless sand, in houseless land,
  Free as the air I roam;
Where my loved maid our tent has staid,
  There is my constant home.

With wife and child, and fleet steed wild,
  No other joys I crave:
Let wall-bound man, whate'er his clan,
  Confess himself a slave.

My Nezdj* then, o'er hill and glen,
  With lightning's speed I'll urge;
When wounds and gore bid ride no more,
  Welcome my funeral dirge.

While calling the attention of the youth of America (especially at page 177) to the life which awaits them individually and nationally, according to the judgment which they exhibit in educating themselves and in legislating for posterity, it struck me that perhaps a few precepts, written especially for my sons, might, perhaps, prove to other youths also useful and acceptable

ADVICE.

Be Truthful: Whatever be your other faults and failings, if you adhere steadfastly to this rule, there is hope that you will conquer them. Much of the evil existing in the world results not only from deceit and equivocation, but even from want of sincerity and candor.

Be Just: Whenever at a loss how to act towards others, test your conduct by the unfailing Christian precept, in the form of a question: "How would I desire my neighbor to act towards me?"

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* One among the purest breeds of Arabian horses.

When prompted by our feelings to be generous, we must reflect, first, whether we can be so without injustice to some others.

Be Temperate: As being healthy, next to being virtuous, contributes, in my opinion, most to happiness, and as health depends, in a great measure, upon our acquiring such complete control over our desires as to do nothing of which our judgment disapproves, I cannot too strongly recommend the practice of temperance in all things. If unable to resist, avoid temptation.

Be Industrious: Idleness, it has well been said, is one of the great sources of evil. Select, therefore, early in life the profession or occupation which seems best suited to your circumstances, inclinations, and abilities; then pursue, steadily and undeviatingly, the course best adapted to perfect you in the knowledge and pursuit of the business or occupation selected.

Be Frugal: No matter what your wealth, let there be no expenditure merely for ostentation. Live upon less than you make, so as to avoid one of the greatest of evils under which we can exist, *debt;* and live so as, if possible, to provide in mature age something for the period of life in which we are less capable of exertion.

Be careful, through your whole life, in the selection of your companions: Man is essentially a creature of sympathy and of imitation, and some dispositions are peculiarly susceptible of influence from others. In that case it is particularly desirable that our companions be those best calculated to exert, at all times, a beneficial influence.

Be Orderly: It is both a saving of time and money to be, at all times, neat in our persons and habitations, punctual in the fulfilling of our duties and engagements, consistent and methodical in our pursuits.

Be Chaste, in thought, word, and action. It is unworthy the character of a gentleman to be otherwise, under any circumstances.

Be particular not to form any habit until you are sure it is a good one, or, at least, not likely to be injurious. It is much more easy to *avoid* a bad habit, than to *eradicate* it when formed.

Be Charitable and Benevolent: neither forgetting the misfortunes of others, nor your duties to them; and bearing constantly

in mind the bright example which breathes, "Peace on earth and good will towards all men."

Finally, let your constant desire and endeavor be to acquire, as far as is permitted to mortals, *a knowledge of the immutable laws that govern the universe, and the power to live always in accordance with those laws.*

Note referred to at page 178.

While recommending measures for the promotion of social intercourse, of relaxation from business, and for innocent, even instructive enjoyment, I ask permission to reprint, in the Appendix, a plan for pleasure-grounds, laid out on a geographical basis, combined with specimens in Natural History, with lectures, etc. This communication was originally furnished for the May number, 1856, of the "Tennessee Farmer and Mechanic."

GEOGRAPHICAL GARDENS.

The day has passed when the love for the grotesque and the stiffly symmetrical induced the gardener to clip the outline of leafy trees into fantastic forms; and on one occasion, as some person has related, even to put a boy, who had committed no offence, to look out of one of the tool-house windows, for no other reason but because one of his apprentices, who had neglected his duty, and had been punished by confinement in a corresponding outhouse, was looking out at a similar window.

The mania, too, which induced the Hollander to give a thousand dollars or more for a single tulip, is fast giving place to more rational and natural horticultural taste.

In accordance with the demand for the useful and the naturally picturesque, combined with the gracefully cultivated, (yet without passing to the ultra artful, depicted in Harper's description of the world as expected to be in the year 3000,) a plan occurred to me for a garden, which, although partly adapted to circumscribed grounds, demanding only labor, would be best carried out on a large scale, in a public garden, upon which a considerable amount of funds could be expended.

A piece of ground, of a somewhat rectangular form, already set in grass, may be selected and laid out on the plan of Mercator's projection of the world, or some similar modification; the outline of the coasts, after the sod has been pared from the surface, being marked by white shells, such as are used on the road from New Orleans to Lake Ponchartrain; or, in default of shells, by gravel mixed with lime core. This is done in order to mark the distinction between sea and land; and the gravel may extend all over the oceans, constituting dry and pleasant walks—or, on a large scale, carriage-drives; while rivers and lakes dwindle into narrow foot-paths.

Each portion of the land is then to be planted with appropriate vegetation. In the arctic and antarctic regions might be cultivated the cryptogamia—as ferns, mosses, and lichens; also some firs, pines, cranberries, etc.; in the torrid zone the intertropical vegetation. Should the actual latitude of the garden site not permit the growth of tropical plants, they might be raised, when space and funds permitted, in hothouses or greenhouses, arranged, if desired, according to the natural system of Jussieu.

In the portion allotted to the United States, even the products of each State might be cultivated—as the sugar-cane in Louisiana; the cotton-plant in Georgia, Mississippi, and Alabama; Indian corn in Tennessee; rice in the Carolinas; tobacco-plants in Virginia and Kentucky; hemp in Missouri; the live-oak in Florida; and some domestic fruit-trees in the Northern States.

In Mexico would flourish the cactus, maguey plant, and fig-tree; in the West Indies, the coffee shrub and banana; in South America, shrubs or trees producing coffee, chocolate, Peruvian bark, and India-rubber; while, passing to Europe, either on foot over the gravelly bed of the Atlantic, or (if you choose to introduce water into the garden) in a canoe or boat over the miniature ocean, we would find, in Scotland, oats, the thistle, and heath; in Ireland, its national shamrock, (or wood-sorrel,) and flax; in England, barley and the hop. The vine would characterize France and Germany; the juniper-tree, Holland. Italy might claim the olive, myrtle, and pomegranate; to Greece we may yield the poetic laurel, (Daphne,) although not our mountain laurel, (Kalmia,) equally beautiful, perennial, and worthy to wreathe the brow of intellectual victory; to Persia we may concede the peach, although it luxuriates in our

own Jersey State; to Spain, its Seville orange, (perhaps no better than in Louisiana and Florida;) to Arabia, its enlivening Mocha bean; to China, its fragrant, soothing "imperial" and "oolong;" while the narcissus, anemone, and ranunculus might decorate their native Turkey, or mignonette spread fragrance in Egypt and Palestine; but the humble violet and lily of the valley, the graceful periwinkle, the unrivalled rose, the fragrant sweetbrier and honeysuckle, with many more such, too universal favorites to be circumscribed in narrow limits, might diffuse their cosmopolitan power of gratification, at least over all the temperate zones.

To this botanical distribution of plants might be added geological information, by laying off the principal mountain ranges with appropriate material, as granite, limestone, sandstone; a mass of coal, to designate the coal-fields of Nova Scotia, Massachusetts, Pennsylvania; of Illinois and Indiana; of Iowa and Missouri; (not omitting Great Britain, France, Belgium, and Germany, etc.;) lead ore in Iowa and Wisconsin; iron ore in Pennsylvania, Missouri, and Tennessee; basalt on the north shore of Lake Superior; copper on its south shore; tin in Cornwall; graphite in Cumberland, (England;) slate in Wales; Parian marble in Italy; porphyry in Egypt, etc., etc.; while Vesuvius, Etna, Stromboli, Hecla, Popocatapetl, Cotopaxi, etc., might diversify the scene with their miniature craters and solfataras.

Should the scale be sufficiently large, and should natural, or artificially introduced, supplies of water subserve, a rippling mountain-stream might fill Lake Superior, (in which appropriate fishes could sport unharmed;) and, at its farther passage from Erie to Ontario, the rivulet might designate, in its descent, Niagara's magnificent cataract.

Another additional source of instruction and amusement might be added, if solid plaster casts, (well coated with paint, to resist atmospheric influences,) or more durable castings of iron or bronze, were suitably placed to indicate the zoölogical distribution of animals.

Where neither limited space nor means prevented, this department might be rendered yet more attractive, by having stuffed specimens in water-tight glass cases; or, yet better, the living animals, as in zoölogical gardens, only having each occupy its own geographical range.

We might place, for instance, the polar bear and seal in Greenland, the beaver and lynx in Canada, the porcupine and buffalo (bison) in the North-west Territory. The national eagle, the beautiful wild turkey, the lively mocking-bird, and tiny humming-bird, might be distributed through the United States generally; while the grave pelican, cunning gull, and swamp-loving alligator, are confined to their southern portions. In Mexico, we would encounter the fierce-looking but perfectly harmless armadillo; in South America, the nimble monkey and long-necked flamingo.

Crossing over to England and France, we listen, in imagination, to the plaintive nightingale; and, in Spain, admire the soft-wooled merino, (rivalled by its congeners in Tennessee;) in Switzerland we follow the ibex and chamois over their high-peaked glaciers; and in Russia we pursue the sable and ermine. In Lapland's ice-bound soil, we learn the value of the reindeer; in Asia Minor, we recognize the finely-plumed pheasant; and in Arabia are lavish of our gratitude for the useful camel, the noble horse, and the ornamental ostrich. Near the pyramids of Egypt, we espy the sacred ibis, the gaping crocodile, and its egg-destroying ichneumon. In equinoctial Africa, we are reminded of chimpanzee grimaces; the timid maiden is startled in Hindostan by the grim lion and tiger, and springs over to the Moluccas, in order to lavish praises on the splendid bird of Paradise. The pouched Kangaroo seems ready, in New Holland, for its gigantic leaps; and the naturalist eagerly searches New Zealand for some relics of the recently extinct apteryx, or the long-forgotten dinornis.

The ocean might have its whales, sharks, etc.; the Mediterranean, its pearly nautilus and other shells; and some coasts, as Florida, their sea-nettles (acalephs) and corals. Nor should we deny a spot to the busy bee, whose apiary might appropriately be located in Ohio, while Italy and China were allowed their claims to the cocooneries.

Not to let the gigantic mammalia and reptiles of former geological periods be forgotten, we might have a cast of an ichthyosaurus in the Lias of Germany; a mammoth, in the eocene basin of Paris; a megatherium, in the drift of the Buenos Ayrean Pampas plains; a mastodon, in New York, Kentucky, and Missouri; or even a large trilobite, as isotelus megistos, in the Cincinnati or Nashville blue limestone of the Lower Silurian period.

It would extend this article beyond suitable limits to enumerate all the aids which this garden might render to education; but I cannot forbear adding the suggestion, that public lectures on science, literature, and the arts, might be delivered in appropriate buildings, in connection with a museum systematically arranged: the rocks and fossils so disposed in cases, as at once to indicate relative age and geological superposition; the animals not scattered, as usual, indiscriminately through the building, but collected into zoölogical departments, classes, orders, etc. To these add the other illustrative adjuncts, used in the best educational institutions,—as a very large globe, a cheaply-constructed observatory, which might be erected on the flat roof of one of the buildings, models of machinery, historical charts, painted in oil, exhibiting at a glance the synchronism of important events, etc., etc. In this manner the acquisition of knowledge might be rendered infinitely more easy and attractive to all, than when conveyed simply by oral instruction.

It has been complained that there is not sufficient relaxation and recreation afforded to our American community. Let each large city provide such a public resort as these gardens, graduated according to the population, would afford to its citizens, with every convenience for daily recreation—such as rustic seats, mossy arbors, fir-cone summer-houses, and coral grottoes—which good taste and wealth could command; and the city corporations would no doubt find it a pecuniary saving, as much less would then have to be expended in the punishment of crime. The same resort might, at night, be brilliantly lighted, (the gas, or other source of illumination, emanating, if so desired, from the lighthouses on the coasts, and from the miniature volcanoes,) and might be provided, for sale at a moderate charge, with ice-creams and similar wholesome, unstimulating articles of refreshment.

Add to this, if theatrical performances must exist, chaste and striking representations of interesting historical periods and incidents, arranged in chronological succession, and accompanied by music, whose strains should not pour forth negro extravaganzas, but the wonderful productions of nature's most gifted artists.

Not to neglect sculpture, we might have statuary, suitably disposed to illustrate the types of mankind, and to impress on the memories of youth the characteristic features of the various human races.

Workshops, too, dispersed through the grounds, might exhibit the most interesting and useful arts and manufactures.

Even the religion of the different nations might be designated: as Arabia and Turkey by a mosque, with its lofty minarets, for the followers of Mohammed. China, by its pagoda, would bring Confucius to the memory; while, in Hindostan and elsewhere, the altar of the Pagan might remind us how fast the heathen is yielding to the influence of the Christian, as exemplified in the numerous Christian countries, where the cruciform cathedral would serve, at the same time, to illustrate the religion and the style of architecture peculiar to their inhabitants.

With all these adjuncts, we could scarcely fail to render the garden a source of attraction, and a means of promoting moral and intellectual progress in the masses—a scheme that has long been the prominent aim of enlightened legislators.

In thus being hurried into a description of what might be effected by a body of men having a large amount of land and capital at their command, in the vicinity of a populous city, I should greatly regret inducing any one to lose sight of the original design, which was to show, that even a few acres of ground, particularly if attached to an educational institution, might be laid out as a geographical garden, with a moderate amount of agreeable and useful exertion on the part of the students and professors, aided by a few laborers accustomed to ordinary garden-work, and thus add great attractions to their alma mater.

In connection with the duties mentioned, at page 185, as being incumbent upon us in the character of philanthropical legislators, some extracts from an address written at the request of my fellow-citizens of Posey County, Indiana, appearing not inappropriate, are here introduced:

We shall now proceed to give a synopsis of our measures; most of them we have already recommended, and we think they ought to be adopted by all men wishing well to their country. These are:

As little legislation, on any subject, as will protect the rights and property and lives of all citizens equally, leaving every one to

pursue happiness in his own way, whenever that way does not interfere with the happiness of his fellow-beings.

As little expense in government as is consistent with the effective framing of these laws; giving moderate salaries to our public officers: low enough not to induce them to seek for office as a money-making business; high enough not to oblige any competent individual, however poor, to decline a situation for want of the means to support himself.

The reduction of all taxation to the least amount required for the frugal administration of the government.

The thorough reform of our militia system, so as to qualify each citizen to act simultaneously with his neighbors in the mutual protection of their families and property.

The speedy establishment of AN EQUAL AND UNIFORM SYSTEM OF EDUCATION throughout the Union, based, after mature deliberation, on the best plan anywhere in existence.

As little party spirit as will suffice to watch faithfully over, and maintain in their purity, all our political principles and actions.

. . . . . .

It is difficult sometimes to know, when we pass an opinion upon the acts of others, whether our approval or disapproval may not arise from our being accustomed to think that *this* party can do little wrong, and *that* party can do little right. Our safest guide is consequently *to test every measure by such first principles as all republicans admit to be the basis of just government.*

We should also endeavor to consider ourselves in the situation of the opposite party, before giving to their acts the worst construction of which they admit; we should reflect that some of our opponents conscientiously, and after mature reflection, believe an opposite policy likely to benefit the country, while others *really believe as we do,* but have been accustomed to call themselves by a different *party name;* and our earnest endeavor should be not dogmatically to dictate, but calmly to suggest and persuade; not to attempt to prove one or other party triumphant, but to endeavor always to discover TRUTH and discard error, wherever they are to be found.

To all good men, of whatever party name, we would say further: Let us ever remember that we are the *only truly Republican Nation on earth;* that to us the rest of the world looks for the proof whether Republics can or cannot prosper; let us reflect that upon *that* proof

depends the fate of numberless other nations; let us consider that in our downfall kings and tyrants will triumph, that in our success all good men throughout the world will rejoice.

United then, notwithstanding our difference of opinion on various minor subjects, let us prove incontrovertibly to the world THAT A REPUBLICAN CONFEDERATION IS THE MOST PERFECT OF ALL POLITICAL COMPACTS.

Note to page 185.

The following powerful appeal to the young, by Jean Paul Richter, translated from the German by my sister, Mrs. Fauntleroy, I have so frequently read with appearance of advantage to our young students, that I cannot forbear introducing it for the benefit of "Young America" in general, whom I view with the same affection and anxiety that might be felt by one who saw the favorite child of his adopted and much-loved mother rashly bounding on the brink of a precipice. I do not remember having seen in print any other translation of this beautiful piece.

NEW YEAR'S EVE OF AN ERRING ONE.

At midnight, on a New Year's Eve, an old man stood gazing from a window, with a look of deep despair, upon the immovable and eternally glowing firmament; then cast his eyes downward upon the quiet, pure white earth, on which no one existed so joyless and sleepless as he; for his grave stood near him, concealed by the snows of age, not by the verdure of youth. Out of his rich, promising life had he brought nothing but errors, lies, and disease; a body laid waste; a soul desolate; his breast full of the poison of remorse, and an old age haunted by repentance.

His beautiful youth-days returned upon him like spectres, and carried him back to the happy hour when his father first placed him at the starting-point of life: two paths before him, one on the right, the sunlit path of virtue, leading to an open, bright, and tranquil land, full of angels and angel-gifts, the rewards of well-doing; one on the left, leading downwards in the mole-tracks of vice to a hideous cavern, full of dripping poison, serpents ready to dart on their prey, and dank, noisome vapors.

Horror! the serpents seized upon his breast, the poison distilled upon his tongue; and now he knew where he was.

Unspeakably moved, he called distractedly upon Heaven: "O Father, give me back my youth. Place me again at the starting-point of life, that I may choose that *other* path."

But his father and his youth were far from him. He saw false lights dance over the marsh, and become extinguished at the grave-yard; and he said: "These are my erring days."

He saw a star shoot from heaven, glimmer in falling to the earth, and then vanish. "That is myself: behold my destiny!" said his bleeding heart; and the serpent-fangs of repentance struck deeper into the gnawing wounds.

His excited imagination peopled the roofs around him with flitting phantoms, imps of darkness; and the neighboring windmill seemed to raise its arms, threatening to crush him; while a Death's head, which had been left in an empty charnel-house, assumed by degrees his own features.

During this strife of feeling, suddenly were heard, sounding from the tower below, like a distant anthem, the New Year chimes. His mind became less agitated; he looked around the horizon and over the wide earth, and thought on the friends of his youth, who now, happier and better than he, were teachers of the earth, fathers of happy children and blessed men; and he exclaimed: "I also, on this first night of the year, might have reposed with tearless eyes, if I had so willed it. Alas! I might have been happy, dear parents, had I fulfilled your New Year's wishes, and obeyed your instructions."

Amid these feverish reminiscences of his early days, and under the influence of that superstitious feeling which invests New Year's Eve with the power of calling up spirits, and foreshadowing future events, the head, anon an empty relic of the charnel-house assuming his own features, was transformed into a living youth.

He could endure the sight no longer; he covered his eyes, a thousand hot tears streamed into the snow, sullying and dissolving the pure elements. The acuteness of his anguish was softened, yet, disconsolate and bowed down to the earth, he could only gasp forth: "Return again, beautiful days of my youth, return again!"

And his youth did return: for he had only on this New Year's Eve thus fearfully dreamed; he was still a young man; *his errors*

alone had been no dream. But he thanked God that he, yet in the spring-tide of life, could still turn from the fatal ways of vice, and enter the sunny path, leading to the pure land of everlasting rewards.

Turn with him, my youthful readers, if you too are in the way of error. Turn with him! Else may this fearful dream in future become your judge; and when you will mournfully entreat, Return again, beautiful days of my youth, they will never return.

Note to page 186.

Perhaps there can be no more suitable subject with which to close the recommendations, deduced as inferences from a study of the Divine laws through which the universe is governed, than admonitions calculated to diminish that most fearful of social evils, *Intemperance.* The lecture, from which the following are some extracts, was delivered March 19th, 1849, at the request of the citizens of New Harmony, on occasion of the anniversary of a Temperance Society, of which, although not a member, I was known to be an ardent well-wisher:

The object of such societies I conceive to be the exertion of a mild, philanthropic, fraternal influence over its own members and other individuals, so as by example, precept, and mutual pledges of assistance, to endeavor to cure, in ourselves and others, injurious habits already formed, or of preventing in future, particularly in the rising generation, the formation of such habits.

. . . .

Here is a subject of thrilling interest to us, to our children, to posterity. Upon our success, and that of similar societies, depend our future happiness, our very existence as a great and republican nation.

To this subject thousands over the habitable globe are bringing their best exertions to bear. To it the real Christian, the true philanthropist, the benevolent and enlightened spirits over all the civilized world, are devoting their time and their talents. Such a subject well demands the utmost stretch of pulpit eloquence; it well deserves the highest flights that oratorical language can suggest. But even the still small voice of zealous reform will be heard

in the glorious cause, although uttered in plain and simple language. Such mite I would now add to the great contribution.

In pursuing this investigation, let us first consider the evil effects produced by intemperance; then the cause; and, lastly, the cure of that most unfortunate habit.

. . . . . .

At a later period, when youth is ripening into manhood, the influence of the female sex is usually, and would be always, if well directed, a powerful incentive to temperance and virtue. The cerebral development, (as many suppose,) the natural character, the circumstances that surround the gentler sex, exposing them less to the turmoil of the world, to temptation and tumultuous passions, and more to the exercise of self-denying virtues and patience in watching over their children, or the sick-bed—all predispose them, more than man, to temperance.

And when they see young men looking to them as their future wives, courting their esteem and guiding each action by their approving smile, they ought sooner to sever the right hand from their body, than to encourage their future husbands in the practice of aught but virtue and temperance; they ought sooner to smother at once, in its germ, the generous emotion of love, and resolve, if necessary, to lead the isolated life of celibacy, than thus to link their fate with that of an intemperate man, whatever his other virtues; than thus to make an inebriate the father of their children; than thus to throw upon the world a depraved and ignorant offspring. As surely as the sun appears to perform his diurnal revolutions, so surely will such conduct prepare for themselves, as wives and mothers, hopes crushed as soon as raised, lengthened days of misery, sleepless nights of deep despair.

If they believe not argument, let them ask experience; let them inquire of those who heard not or understood not the forewarning, and, after venturing all in the lottery of life, drew a ruinous blank. To aid such wives, such mothers, to snatch from utter ruin the victims of intemperance, to assist in forming the youthful mind to virtue and self-government, for these and similar purposes of social reform, were Temperance Societies formed; for such glorious, good and great ends have the members of this Society labored weekly *and daily; for* such objects let them continue to labor, as long as *one individual* within their influence remains to be reformed.

Some persons object to the formation of such societies. They contend that it would be better silently and sincerely to reform at home, in private. This we grant at once, if it could be done. But when we see men who have become habitual slaves to this unfortunate passion, when we see them struggling fruitlessly with the demon, when we know that the sight of their starved children, of their agonized wife, of heart-broken parents, of lost friends, character, and fortune, that death itself, in its most appalling form, cannot deter them, cannot cure them for one week, one day—is it reasonable to expect that they can effect a reform, unaided and alone? Is it humanity to hold back, (because, forsooth, we have escaped the temptation,) instead of lending hand and heart to form and support such societies? Why should we hesitate to avail ourselves of one of the strongest and best feelings of our nature—sympathy—in searching for a cure? why evince apathy in a cause, when we know not how soon a friend, a brother, or a beloved child, may require its aid? Is it probable, is it possible, that such societies should exist and prosper without the aid of the temperate?

Is it immodest, indelicate, unsuitable that woman herself should contribute where her feelings are so strongly interested? No; the glorious work of reform must progress despite of its enemies; despite of incorrect argument and opposition. We have daily proof how much has been effected; we have cheering evidence in our own small town. And if occasionally some are found to backslide, let us not be discouraged—let us redouble our efforts. I do not mean that we should keep up a constant mental agitation, and in the moment of excited enthusiasm call for signers to the pledge; but I advise that we judiciously and perseveringly lay before the public and our citizens, in the plainest and strongest language, the evil effects of intemperance, the ease with which such habits are unguardedly formed, or might be prevented by care, in early youth. Let us pledge ourselves, each to the other, to watch over our wayward passions, to give, by example and advice, a correct, a temperate tone to public opinion. This is the great engine of reform. Man is essentially gregarious, and if he sees others around him moderate in indulgence, and hears their constant disapproval of intemperance, he is insensibly drawn into the current, and glides happily along in the stream of life. But to effect reform, to check

the first aberrations, to point out the earliest indications of intemperance, we must use the voice of friendship, of persuasion.

And when perchance a wife finds that her husband, the father of her children, is acquiring the habit of intemperance, let her especially beware of using angry or upbraiding language. Departing love and virtue were never recalled by the voice of reproach. Let her by gentleness and kindness, by making his home comfortable and his children affectionate, induce him to forget and to forsake his dissipated companions; let her, in his moments of sobriety, (never when he is the least under the influence of intoxication, but when sober and remorseful,) show him his helpless babes; let her speak of her nights without sleep, her days without hope; let her beseech him, as he desires to save his body and soul from utter ruin; let her conjure him by every argument which her strongly interested feelings can suggest, at once and for ever, to dash the claw-fast demon, the incubus of intemperance, from his bosom; let her march with him to the desk of the temperance secretary and aid her husband's palsied hand to sign the pledge of reform; that pledge, which does not, as some contend, rob him of his liberty, but which restores to him his freedom, his own mastership, and snatches him from the basest and most slave-making tyrant in existence, *Intemperance*.

. . . . . .

Can there be a more glorious, a greater cause than this?

And when successful, when by these means we have triumphed over one vice in the fagot of human evils, we will still continue to avail ourselves of this powerful and efficient means, *Social Union*. We will, by the aid of such societies as these, trample under foot, gradually, one by one, the other most prominent vices, which we feel detract from our happiness and utility. Then shall virtue and intelligence be universally diffused over the habitable globe, and happiness, the object of all, from the cradle to the grave, will crown our triumphant efforts.

DESCRIPTION OF MAP I.

Map on Mercator's Projection. The eye is supposed to be situated in the centre of the sphere; the points on the globe are projected on to an enveloping cylinder-cover, which is afterwards supposed to be cut, parallel to its long axis, and unfolded or displayed as a plane surface.

This Map is carefully reduced from Colton's latest, and is designed to facilitate the understanding of the gradual successive upheavals, to the surface, of the various stratified and crystalline rocks, acted upon by internal contending forces, the effect, probably, of solar influence.

The lines N^1, X^1, N^2, mark a Great Circle of the globe, dividing our planet into two hemispheres, on one of which we find nearly all the dry land, even of the present day, while, on the other, we find chiefly water, the Pacific. This Great Circle indicates, on the surface of the globe, a line of almost continuously active volcanoes.

The Great Circle X^1, X^2, X^3, X^4, and the Great Circle Y^1, Y^2, Y^3, Y^4, indicate longitudinal lines of great expansion and contraction on the earth's crust.

The Great Circles A^1, A^2, A^3, A^4, B^1, B^2, B^3, B^4, C^1, C^2, C^3, C^4, are designed to exhibit the most important intervals in time, and marked differences between the lithological or the palæontological constituents; the stratified materials having been deposited at successive periods, after great convulsions; the crystalline, brought up by these convulsions, accompanying, modifying, and uptilting, at various angles, the aqueous strata, in the manner indicated on the Map. The primitive crystalline materials are supposed to have been upheaved as a pyramidal nucleus, forming equilateral triangles as they came to the earth's surface.

D^1, D^2, D^3, D^4, is a Great Circle, intended to show some of the innumerable positions which the former equator occupied, at various periods, before its conflicting oscillations brought it to rest in the line of our present equator.

If on N^1, X^1, as one side, and X^1, N^2, as another side, we erect a square, M is its centre, and we have four smaller squares, one formed by the lines N^1 O, O M, and their opposite sides, which contains North America; a second square, formed by the lines O M, M P, P X^1, X^1 O, which embraces most of South America, all Africa, and Southern Europe; a third square, formed by the lines M P, P N^2, and their opposite lines, includes all Asia; and the fourth would contain Spitzbergen and other detached northern portions.

Examining the lines N^1 K, K M, M L, L N^2, we readily see how an equilateral tetrahedral surface can be formed, again enclosing nearly all the land.

The colors, beginning at the bottom of the Map and ascending, give us what were designed for red, orange, yellow, green, blue, violet, and red again; intending to indicate, in the descending order from the north, the early Hypogene, in the arctic red, (the latest Hypogene, in the antarctic red,) Metamorphic in the violet, Palæozoic in the blue, Mesozoic in the green, Tertiary in the yellow, and Post-Tertiary in the orange. The red, as indicating the Hypogene rocks, might have been made to appear intermediately between *each* of the aqueous strata or periods; but it was thought sufficient here to indicate its earliest and latest outbursts, and its probable position and extension even under the ocean; from which further outbursts might be expected to take place.

The dotted line W R is supposed to indicate, approximately, the axis of magnetic oscillation about the present period; it points to the Am. Mag. N. P. of Ross; while R G would be at right angles to it, and point to the Sib. Mag. N. P. But the continuous lines near those (passing, one through R, and through the star with an arrow directed to it, which is the Am. Mag. N. P., as given by Lardner, as well as through the Mag. S. Pole; the other a continuous line from R to G) may, perhaps, indicate the extreme limits of secular, magnetic oscillation.

The curved dotted line E O H I P G, was intended to show that many important magnetic points were equidistant from the magnetic centre, R.

Many more lines might have been introduced on this Map to indicate the mathematical figures resulting from the connection of important points, such as elipsoidal curves when several points of magnetic intensity were united; but it was feared that any addition to the already complicated-looking intersections of lines, might render the Map unintelligible.

DESCRIPTION OF MAP II.

The Great Circles A^1, etc., B^1, etc., C^1, etc., D^1, etc., indicate the same upheavals which are designated by the same letters on Map 1.

The design of this Map was chiefly to call attention to the mineral wealth to be obtained along the above lines, which separate the different geological periods. Also to show that minerals of a certain composition prevailed in one period, others in another. An additional object was to present at one view the gradual variation in the Flora and Fauna of different periods, indicating these facts chiefly in North America, with the geology of which I was more familiar, pointing out, however, such parallelism as occurred to me regarding formations, etc., in the Eastern Continent.

Both this and Map No. 1 were put in the hands of the lithographer when I commenced writing the "Key," in order to be ready in time; consequently, such alterations and improvements as occasionally presented themselves could, unfortunately, not be incorporated.

DESCRIPTION OF DIAGRAM I.

The land is supposed to be replaced somewhat as it was before the separation into the present continents: the *dotted* lines indicating those portions supposed farthest submerged, and covered by the parts drawn in *full* lines. Thus, the layers composing the South American Continent are supposed once to have rested on the layers of submerged Africa, particularly in the region of its Sahara. So also Australia is imagined, in some of the earth's early phases, to have been superposed on Arabia, while the points of Cape Comorin and of Cape Horn dove-tailed into its sinuses. Perhaps New Guinea occupied the region of the depressed Caspian Sea.

This approximation, although involving great doubt, is given because it may facilitate the working of the problem, which all desire to solve, regarding the earth's development. An error, which occurred in lithographing, was overlooked in correction, by which the fine, curved line, indicating the end of the Tertiary Period, passes just south of Florida, instead of curving round south of the Gulf of Mexico and south of the Mediterranean.

DESCRIPTION OF DIAGRAM II.

The intention of the Historical Tree has already been somewhat detailed at page 180, and I therefore consider it unnecessary to enlarge upon that which is readily understood, and is merely introduced to facilitate explanations. I will here only further remark, that Turkey, occupying territory not originally its own, is represented by an offshoot; and America might, like the Banyan of India, be delineated as striking, from its branches, new roots into the ground, to form stock more rapidly, and to give greater stability and permanence to its independent existence.

DESCRIPTION OF DIAGRAM III.

Fig. 1 shows the early absorption of nucleiform materials from the sun at the North Pole or point of attachment,* and subsequent successive upheaval of those nucleiform contents of the earth, in the form of a central crystal,—if I may be permitted the term for such an aggregation of materials,—in a regular geometrical tetrahedron, with spherical faces, coming to the surface of the earth's crust as triangles. This figure exhibits, in the dotted line outside of the circle, the supposed expansions and contractions, corresponding to the longitudinal, dissepimental, *carpellary*, cell-expansions in the seed-vessel of the plant.

* *Possibly this* point of attachment and absorption was at M, rather than at the North Pole.

At the angle marked Palestine is the point at which separation and absorption of the lunar nebulous extension or comet-like tail probably took place.

Fig. 2 is intended, by exaggeration in the dotted lines of the observed distances from the earth's centre, to indicate that, besides the increased equatorial diameter, there is an elevation in the earth's crust at about latitude 45° North; and also, perhaps, in the same degree of south latitude, produced, possibly, by the undulatory oscillations of the fluid contents of the globe; those volcanic waves again being due, like the tides of the ocean, to the attraction of the sun and moon, as well as being influenced by centrifugal force.

Figs. 3, 4, and 5, are intended to exhibit forms, in the vegetable world, in which the ovule-bearing placenta resembles the primary crystal or nucleus, formed by absorption from the matrix, the expanding ovule finally making its exit, most usually at that same apex, as the capsule-segments expand and separate.

Fig. 6, erroneously marked Fig. 8, denotes the germination of seed, which may be minutely watched in nature, on the plan suggested in the note to page 24.

There might have been several angular lines, instead of one, to show the integuments thrown back, and the embryo, with its albumen, developing in a manner similar to the nucleiform triangular upheavals, as exhibited on Fig. 1 of the same Diagram, but they were overlooked.

Figs. 7 and 8 were designed to show that the formation of the framework or skeleton of the Mollusk and of the Polyp commences very much in the same manner, viz.: from a central point of consolidation, cells diverging in all directions, and gradually enlarging. When a greater activity exists on one side than another, perhaps from greater stimulus of heat, light, or electricity, so as to expand some cells more than others, then the arrangement of cells becomes spiral around the original axis of commencement.

DESCRIPTION OF DIAGRAM IV.

Figs. 9 to 25. The object of these is readily understood to be an exhibition of the great similarity existing in the consolidation of material in the three kingdoms of nature.

Fig. 9 shows the tendency for mineral materials to aggregate around a central spicule.

Fig. 10 exhibits the fact that, even during such aggregation of the solidifying materials in their most minute structure, the molecules being spheroidal, there will always be interspaces, occupied generally by fluid material, which material, expanding by heat, produces the enlargement visible in bodies exposed to such stimulating influence.

Fig. 11 presents a view of originally molten volcanic materials consolidating, and leaving, by contraction, regular fissures, trending to the earth's centre, which thus not only separate the solidifying mass into hexagonal columns, with their longest axes at right angles to the cooling surface, but even again, by subsequent contraction of the cells forming these columns, often divide them horizontally into shorter prisms, as at the Käsegrotte of Bertrich-Baden.

Figs. 12^1 and 12^2 show that on the faces of the primary tetrahedral crystal there may be materials deposited readily to form either a cube, as in Fig. 12^1, or again, by deposition on the cube, a spherical tetrahedron, as Fig. 12^2, capable of being easily converted, by the action of centrifugal force on plastic materials, into the oblate-spheroidal form assumed by our planet.

Fig. 13 exhibits, in the vegetable world, the primitive cells, with their interspaces filled by sap or formative-fluid.

Fig. 14. The same expanding into tissues, so as to form tubes by the connection of interspaces, such as we find in some acotyledonous and in the monocotyledonous structures.

Fig. 15. The same tubular interspaces elongated spirally, in a higher organization, into vascular tissue, as observed in the dicotyledons.

Fig. 16^1. The single-cell plant reproducing, by fissiparous separation, similar cells.

Fig. 16^2. The cells throw off spores, the analogues of flowering in higher plants; *also of gemmiparous* separation, as well as of the later ovulation among animals.

Figs. 17 and 18. The single cells or rows of a lower organization are here found united in more complex structure, casting off numerous reproductive spores.

Figs. 19, 20, 21, and 22, show that when the materials solidify in the animal economy, and produce osseous or muscular tissue, it is by the granules coalescing to form concentric cells, of which the united side-walls form partitions similar to the medullary dissepiments of the dicotyledonous plant; while the floors of the cells, or horizontal separations of molecules forming ultimate fibril, as in Fig. 24, are the analogues of the transverse separations exhibited by the Bertrich-Baden Basalt, in the left of the two lithographs, placed under Fig. 11; or again, the analogues of the joints or nodes separating the internodes of the stem or ascending axis, as well as of the root or descending axis.

Figs. 23, 25, and 26, are designed to show that the same laws which we had just traced out in the mineral and vegetable world, hold good in the consolidation also of muscle, skin, teeth, etc.; furnishing additional evidence of the beautiful and wondrous harmony which pervades all the infinitely diversified structures emanating from the "Great First Cause."

DESCRIPTION OF DIAGRAM V.

As classification is frequently referred to, it was thought it might enable the reader, not thoroughly conversant with those details, to understand more readily allusions made to the animal kingdom, if a lithograph was executed of a large diagram I painted some years since, for my class. It is based on the data furnished at page 15 *et seq.* of Agassiz and Gould's Principles of Zoölogy; but a modification was adopted by enclosing the *orders* in small circles, these again in larger circles representing *classes*, and afterwards in still larger, denoting *departments:* the whole contained in one large circle, embracing the entire *animal kingdom.* In the original, in order to convey to the eye more readily the distinctive classifications, the circles designating orders were *blue*, and contained within them a painting, illustrative of the type of the prevailing genera,—as a duck for the swimming-birds, etc., etc.,—the circles indicating classes were *yellow*, while those embracing departments were *red*, and the largest for the whole kingdom was *black*.

The different sizes of the circles are intended to convey, approximately, an idea of the relative number of species; and the relative horizontal position of the circles is designed to indicate that the whole did not progress so much from the lowest Rhizopods gradually up to man, as from inferior species in each genus, inferior genera in each order, inferior orders in each class, and inferior classes in each department upwards. In this manner, there need not be much controversy as to precedence of any two orders, classes, or departments: thus, for instance, the departments of Mollusks and Articulates are differently arranged by excellent authority: Agassiz giving the precedence to the Articulates, T. R. Jones to the Mollusks. Inasmuch as we may place in our Diagram each department in equal opposite portions of the ascending circle from the Rhizopod to Man, this difficulty is obviated. The numbers indicate approximately the species known or estimated, as given in the note to page 3 of Agassiz and Gould's Principles of Zoölogy.

DESCRIPTION OF TABULAR DIAGRAM VI.

This explains itself pretty readily, being designed to show that, while all orders of plants and animals became gradually more perfect each on their own particular commencing type, as the earth developed, they also partook of the tendency of those inorganic materials; and that man, following the same law, both in his normal and abnormal condition, exhibits peculiarities somewhat in accordance with the geological and geographical position occupied by the race. The third column from the right is intended to draw attention to the similarity of rise, progress, and decay in every form of created existence. The two last columns, it is hoped, may serve to show how invariably the differing features in government, and even the peculiarities in the *external forms of* our religion, as well as in doctrinal points, depend upon the geo-*logical, geographical*, and other influencing circumstances; a conviction which *should for ever* prevent political and religious proscription.

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Diagram II.

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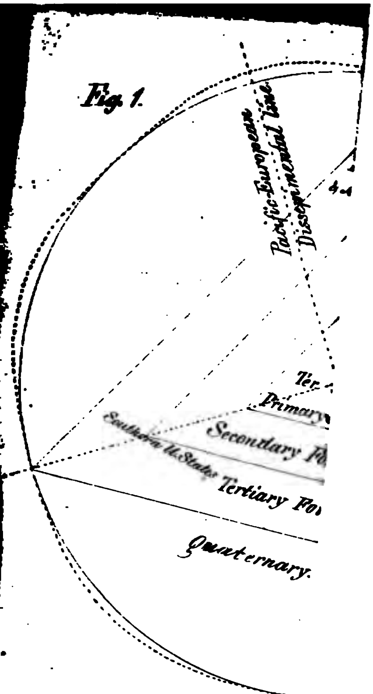
Fig. 1.



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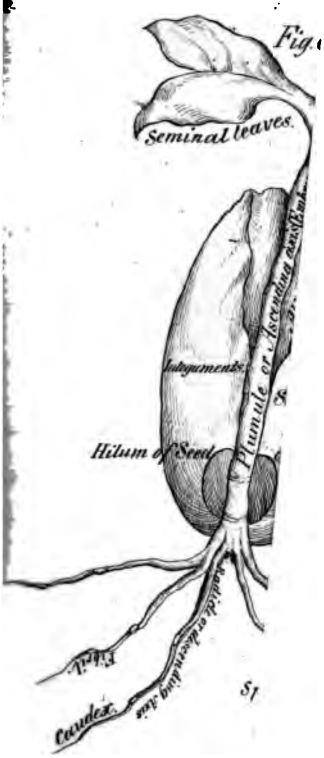

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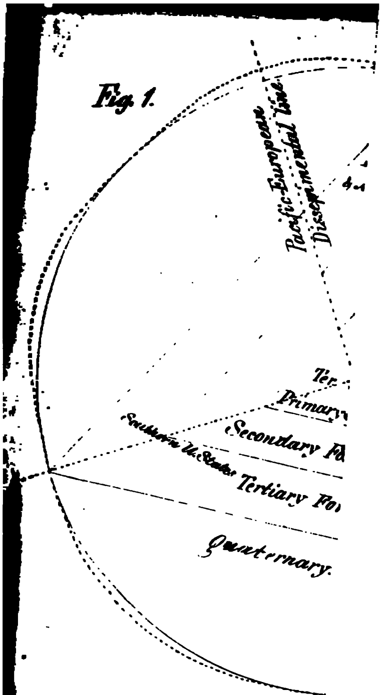

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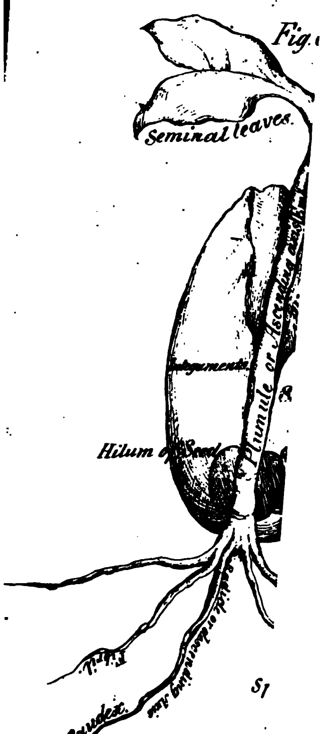

Germination of Se

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